



US011676344B2

(12) **United States Patent**
Li et al.

(10) **Patent No.:** **US 11,676,344 B2**
(45) **Date of Patent:** **Jun. 13, 2023**

(54) **PRESENTING BUILDING INFORMATION USING BUILDING MODELS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 3 days.

(21) Appl. No.: **17/589,842**

(22) Filed: **Jan. 31, 2022**

(65) **Prior Publication Data**

US 2022/0189122 A1 Jun. 16, 2022

Related U.S. Application Data

(63) Continuation-in-part of application No. 17/064,608, filed on Oct. 7, 2020, now Pat. No. 11,238,652, which (Continued)

(51) **Int. Cl.**

G06T 19/00 (2011.01)

G06T 17/05 (2011.01)

(Continued)

(52) **U.S. Cl.**

CPC **G06T 19/003** (2013.01); **G06F 3/0482** (2013.01); **G06T 15/506** (2013.01); **G06T 17/05** (2013.01); **G06T 19/006** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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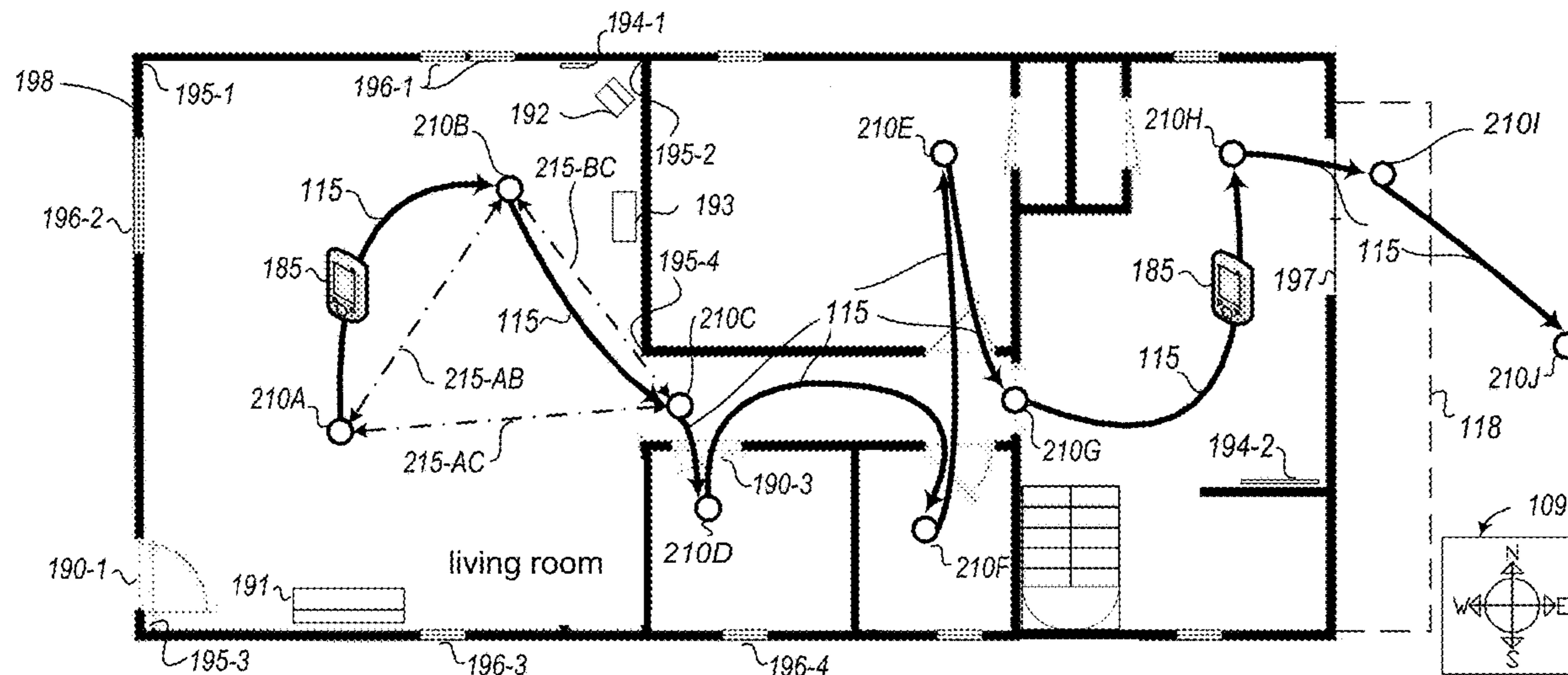
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(57) **ABSTRACT**

Techniques are described for using computing devices to perform automated operations related to providing visual information of multiple types in an integrated manner about a building or other defined area. The techniques may include generating and presenting a GUI (graphical user interface) on a client device that includes a computer model of the building's interior with one or more first types of information (e.g., in a first pane of the GUI), and simultaneously presenting other types of related information about the building interior (e.g., in additional separate GUI pane(s)) that is coordinated with the first type(s) of information being currently displayed. The computer model may be a 3D (three-dimensional) or 2.5D representation generated after the house is built and showing the actual house's interior (e.g., walls, furniture, etc.), and may be displayed to a user of a client computing device in a displayed GUI with various user-selectable controls.

28 Claims, 28 Drawing Sheets



Related U.S. Application Data

is a continuation of application No. 16/681,787, filed on Nov. 12, 2019, now Pat. No. 10,825,247.

(51) **Int. Cl.**

G06F 3/0482 (2013.01)
G06T 15/50 (2011.01)

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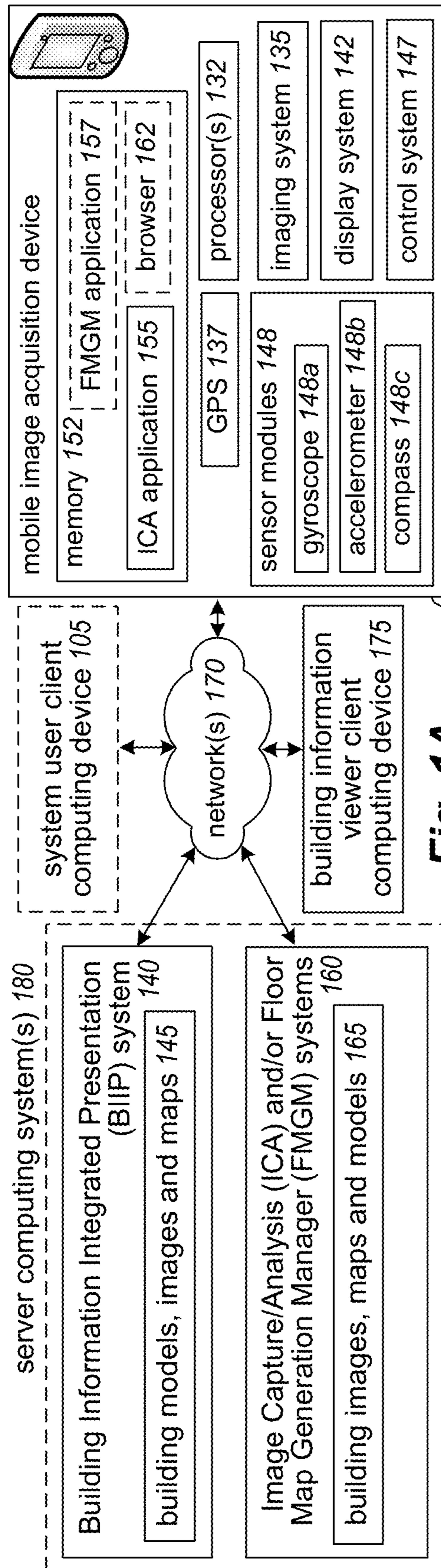


Fig. 1A 185

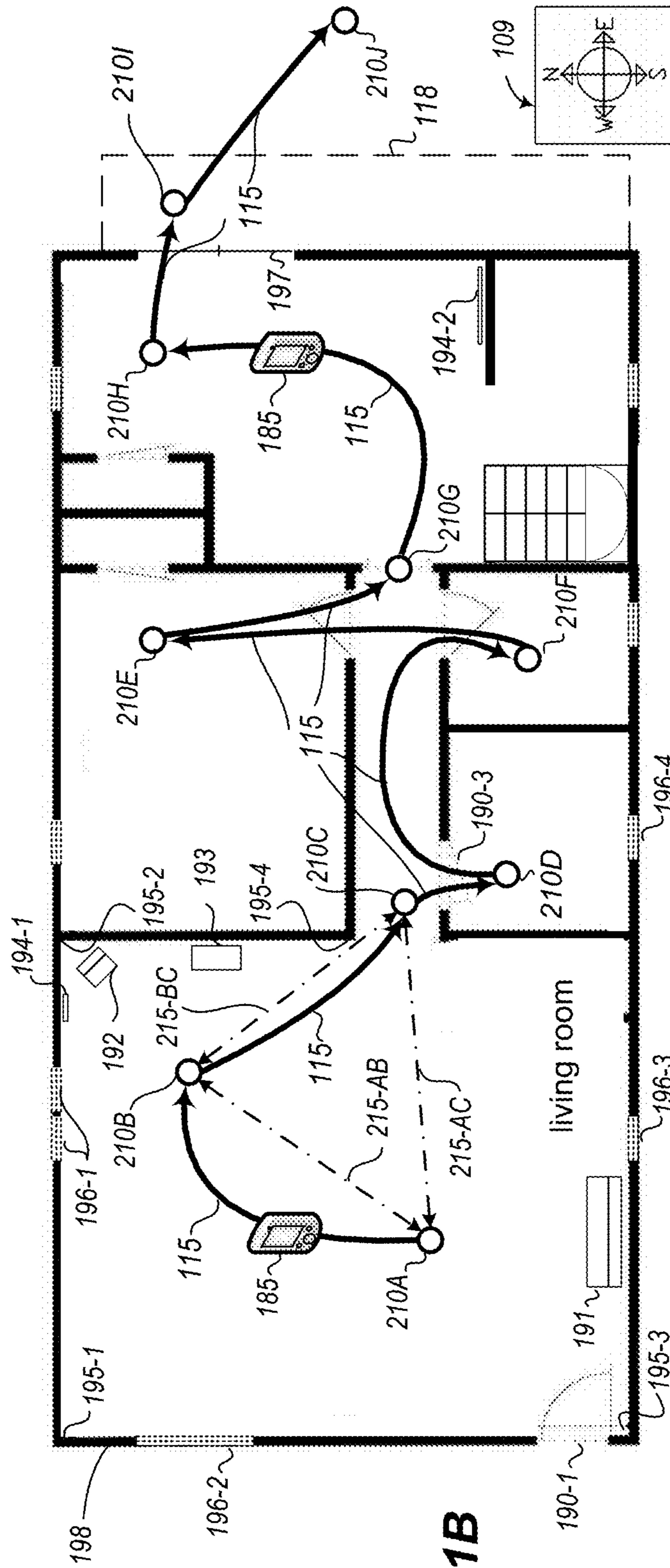


Fig. 1B

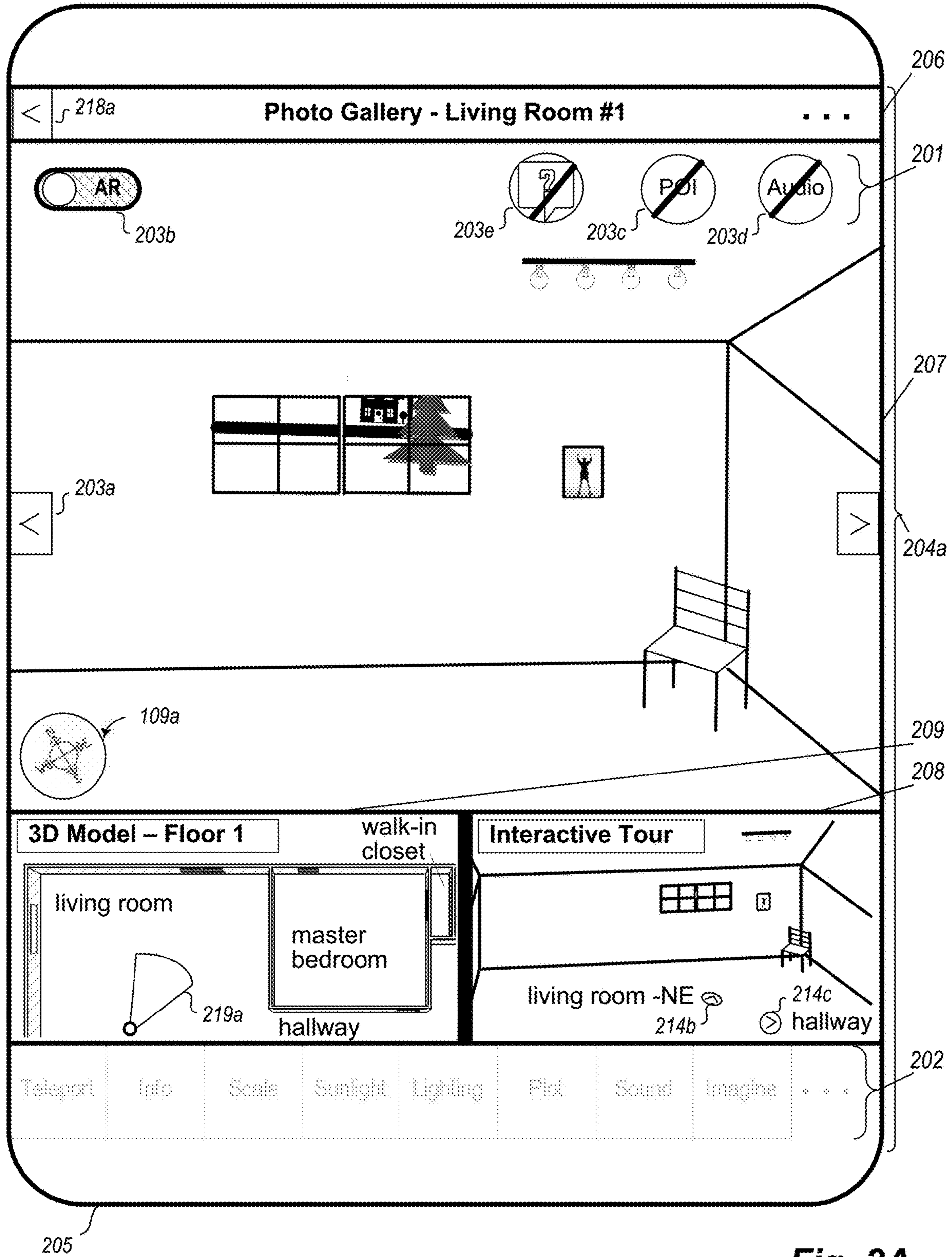


Fig. 2A

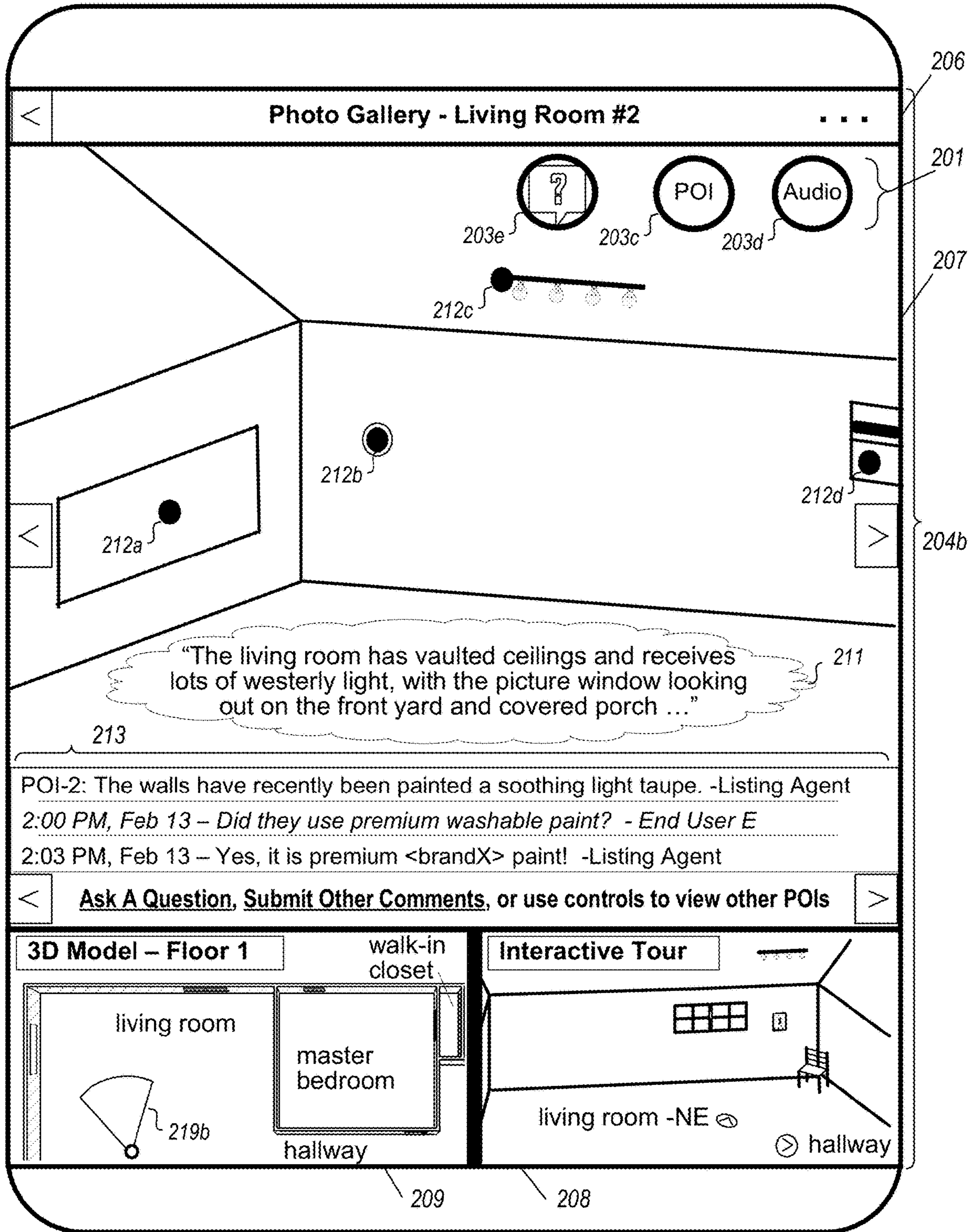


Fig. 2B

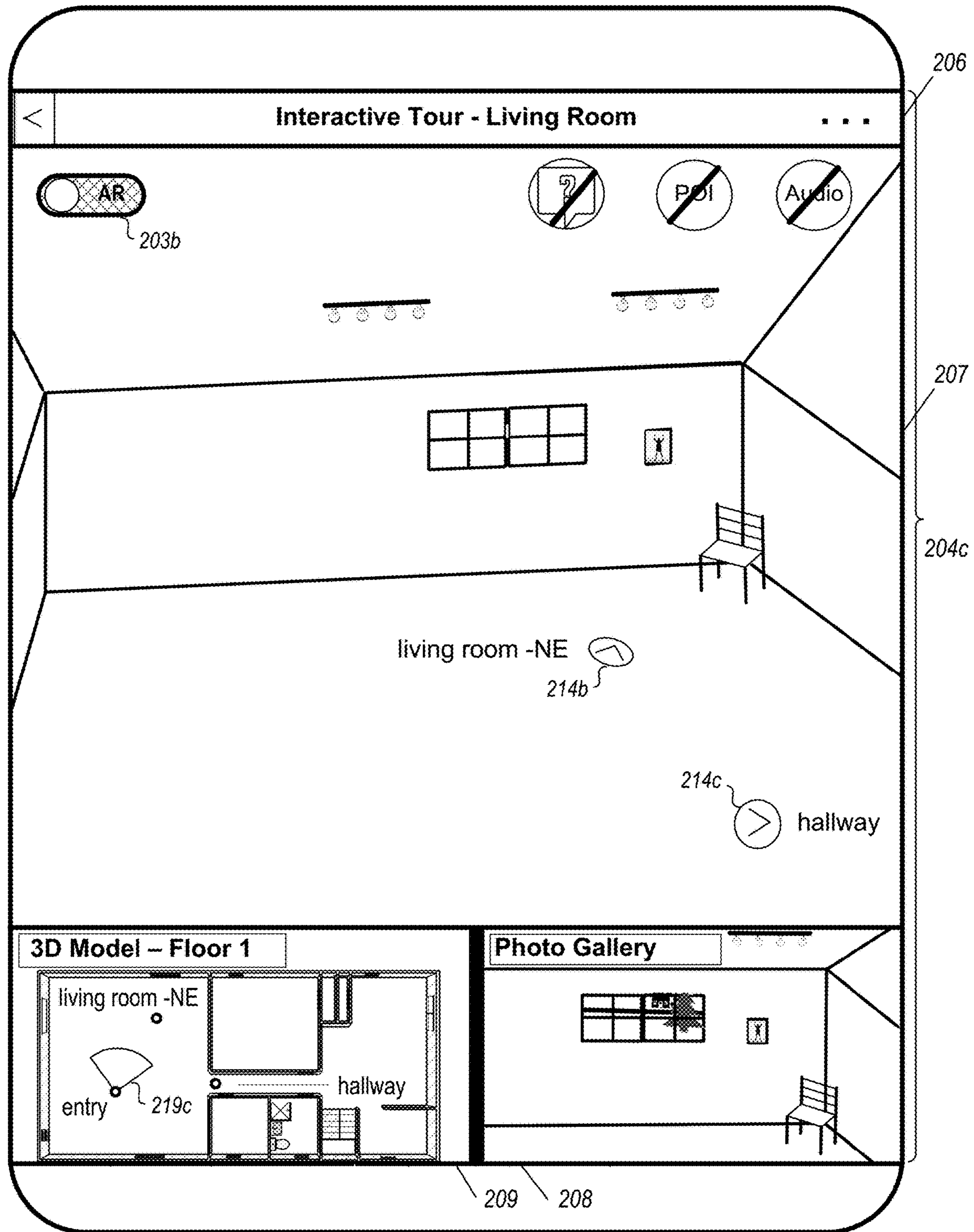


Fig. 2C

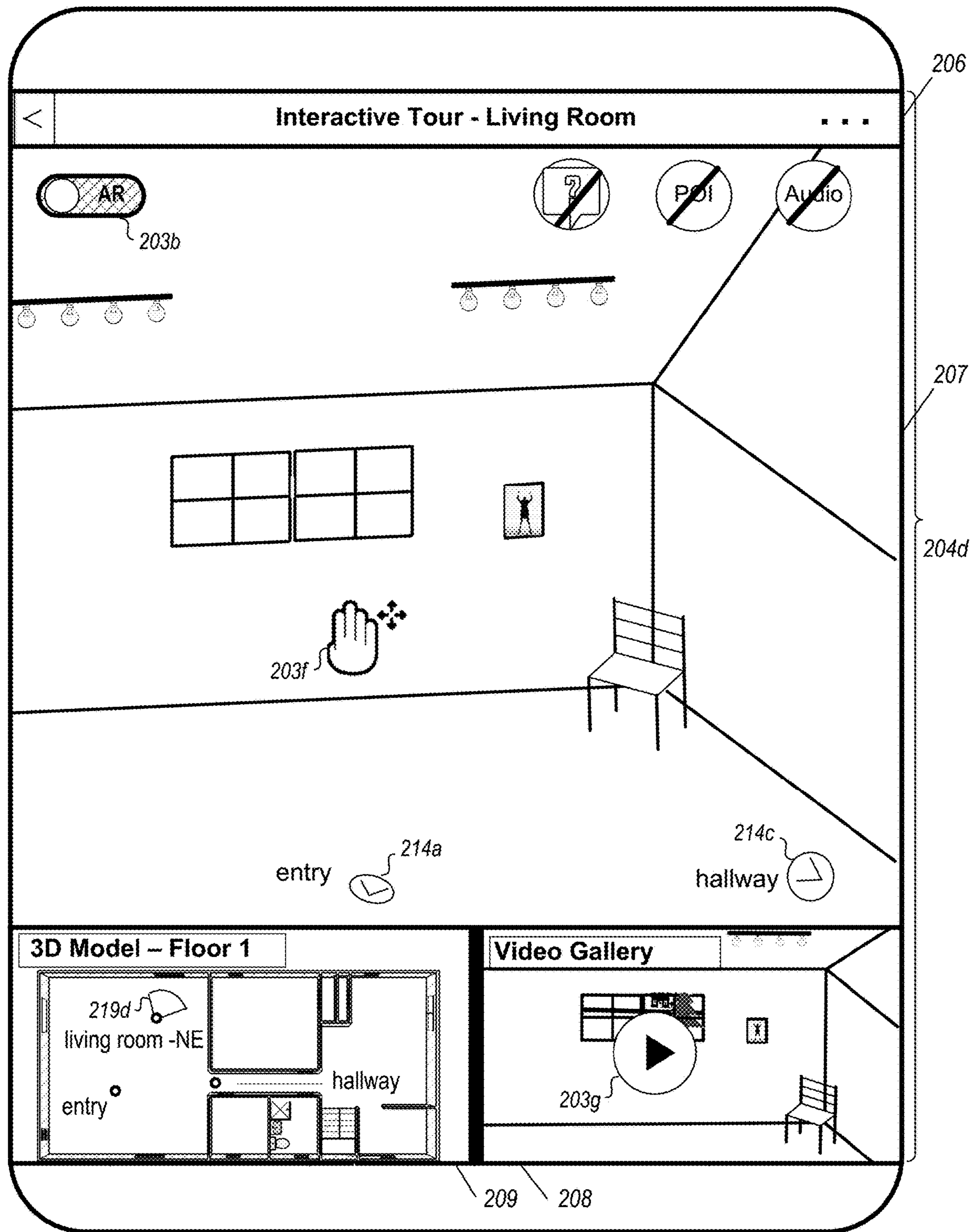


Fig. 2D

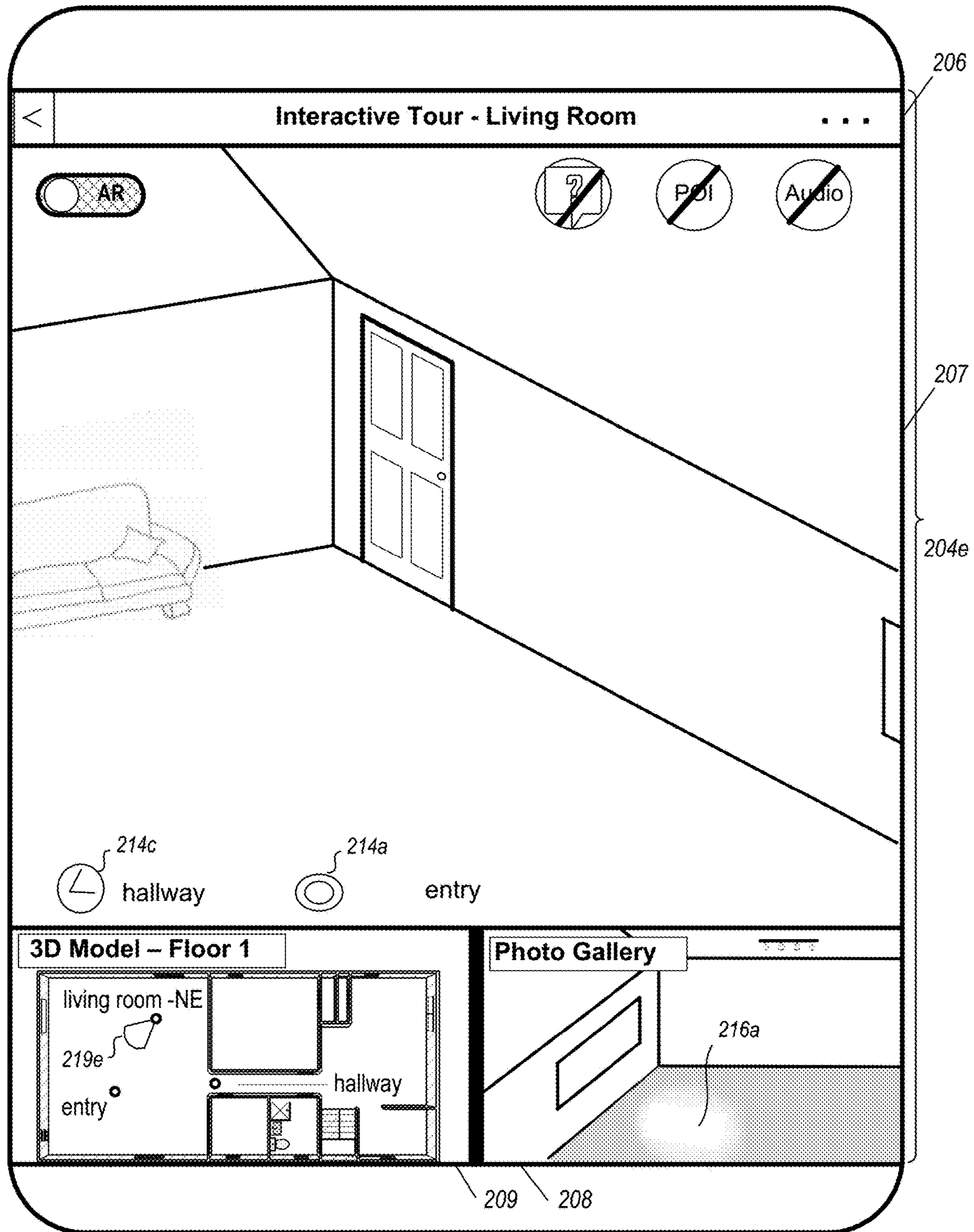


Fig. 2E

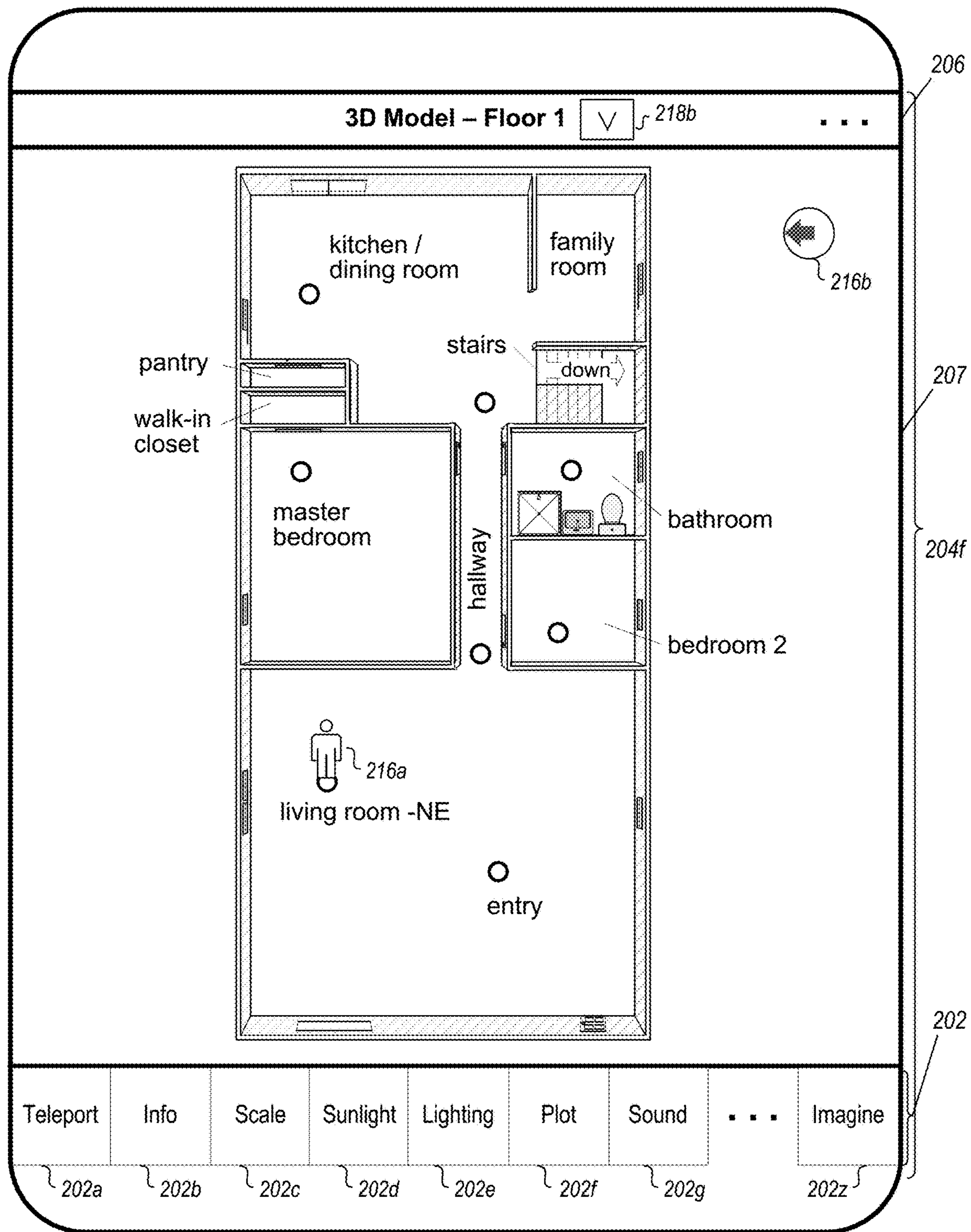
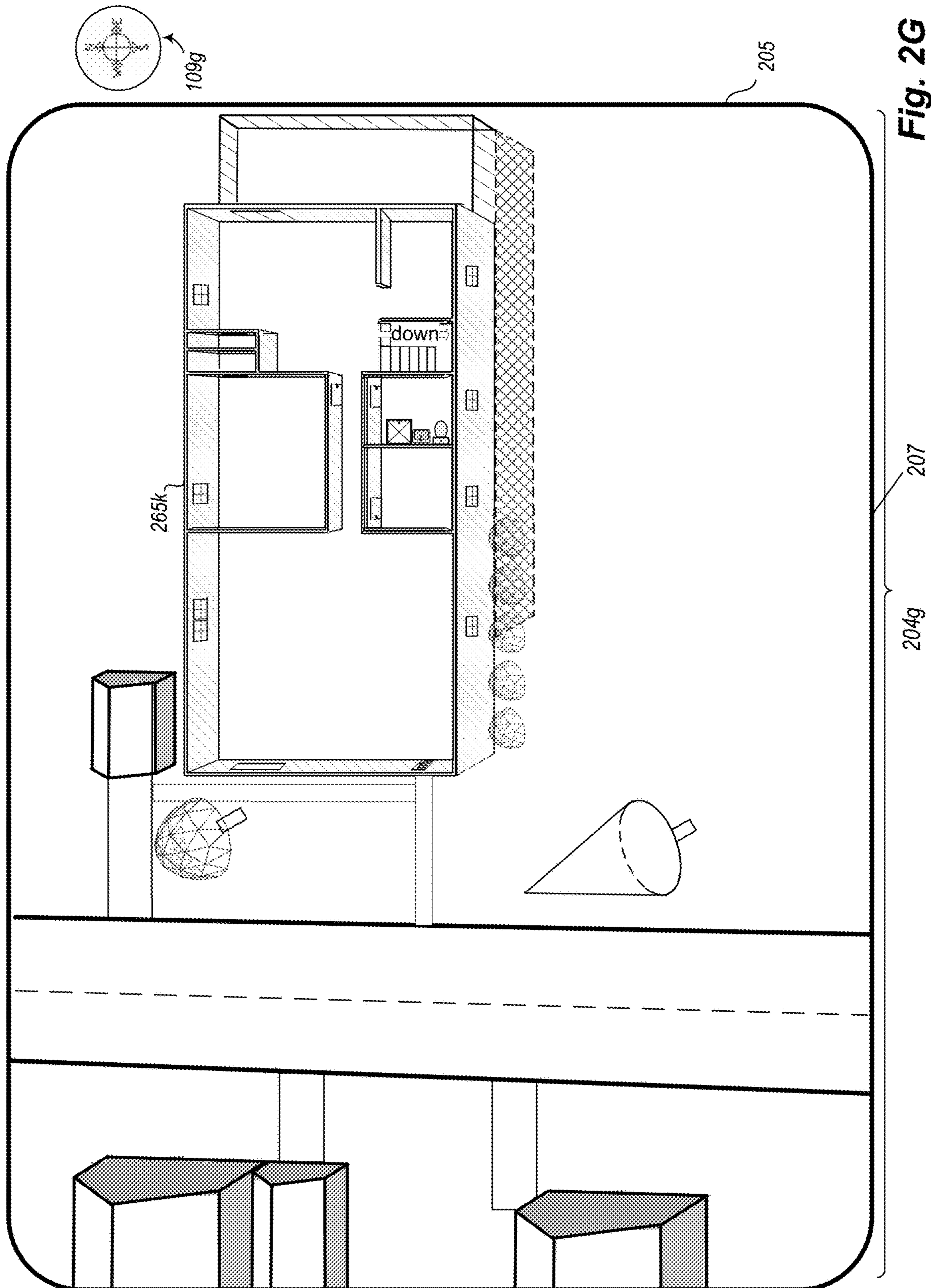


Fig. 2F



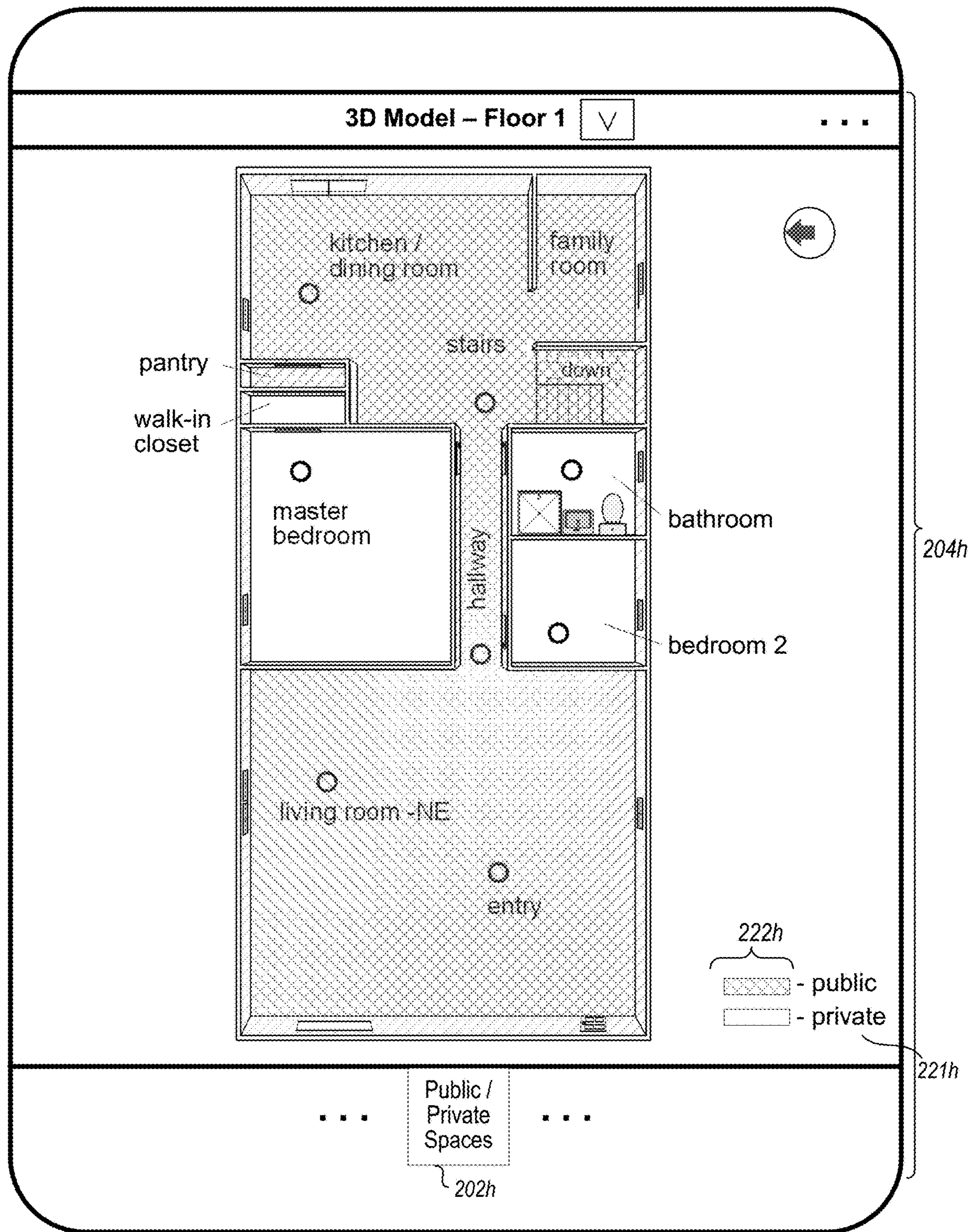


Fig. 2H

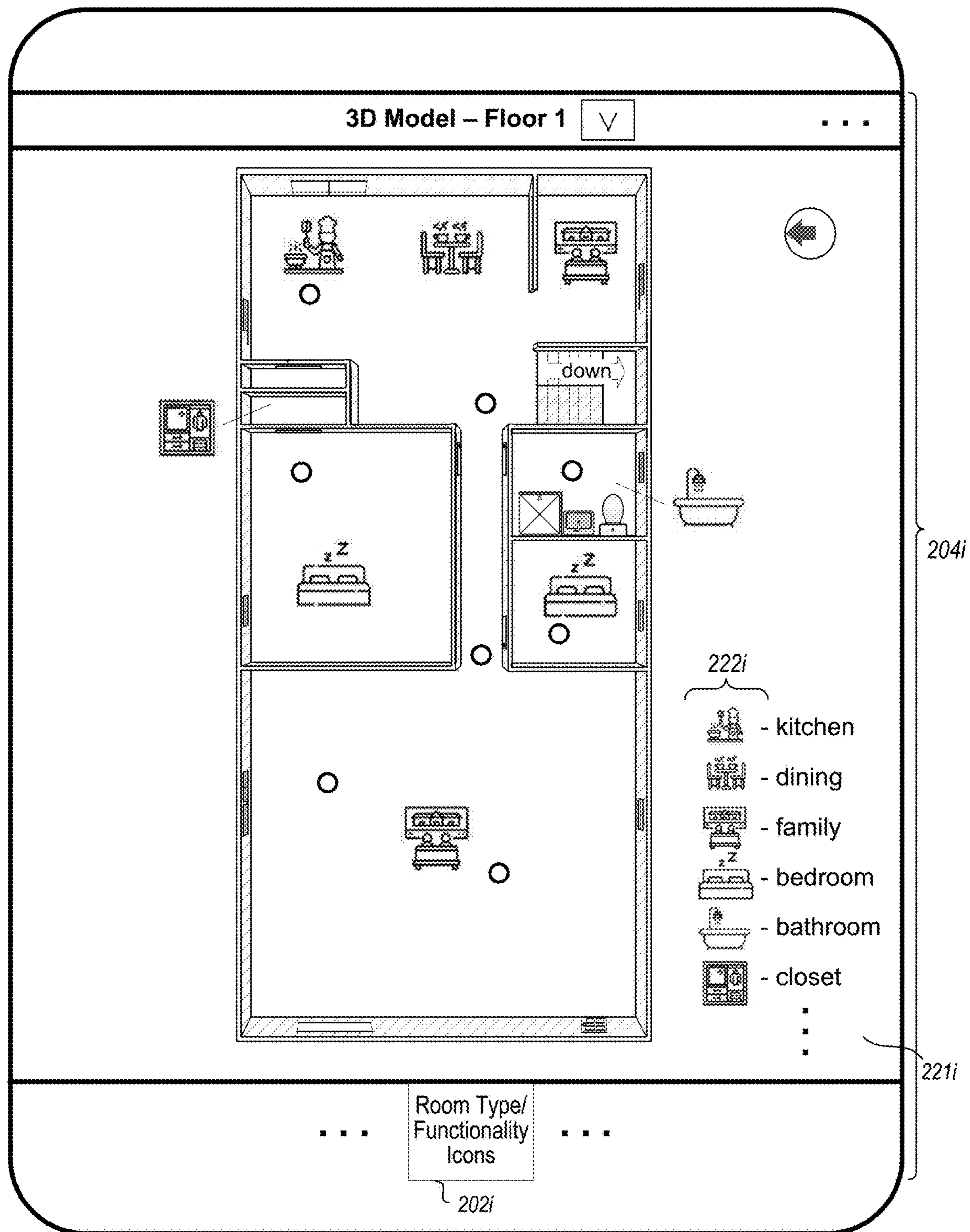


Fig. 21

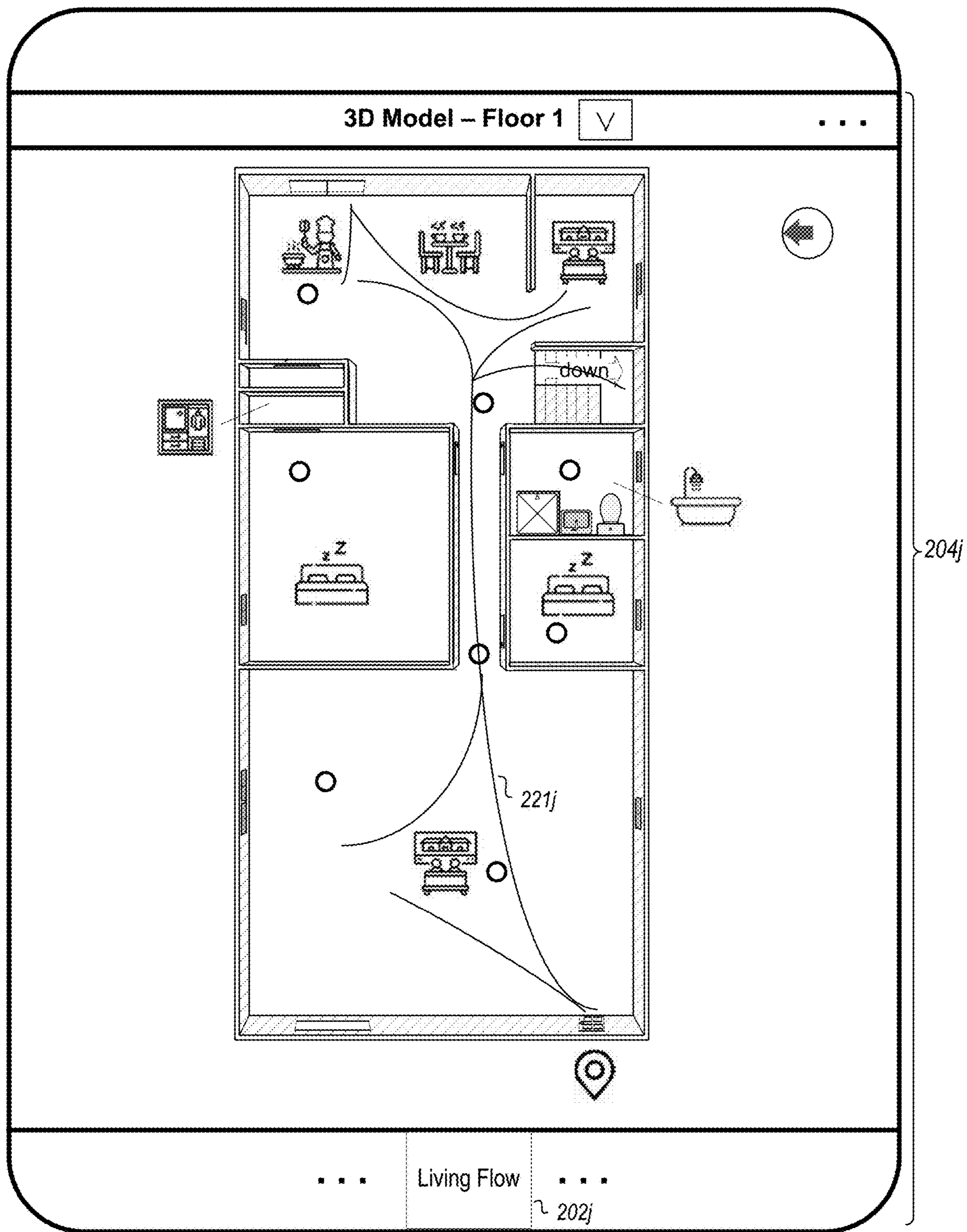


Fig. 2J

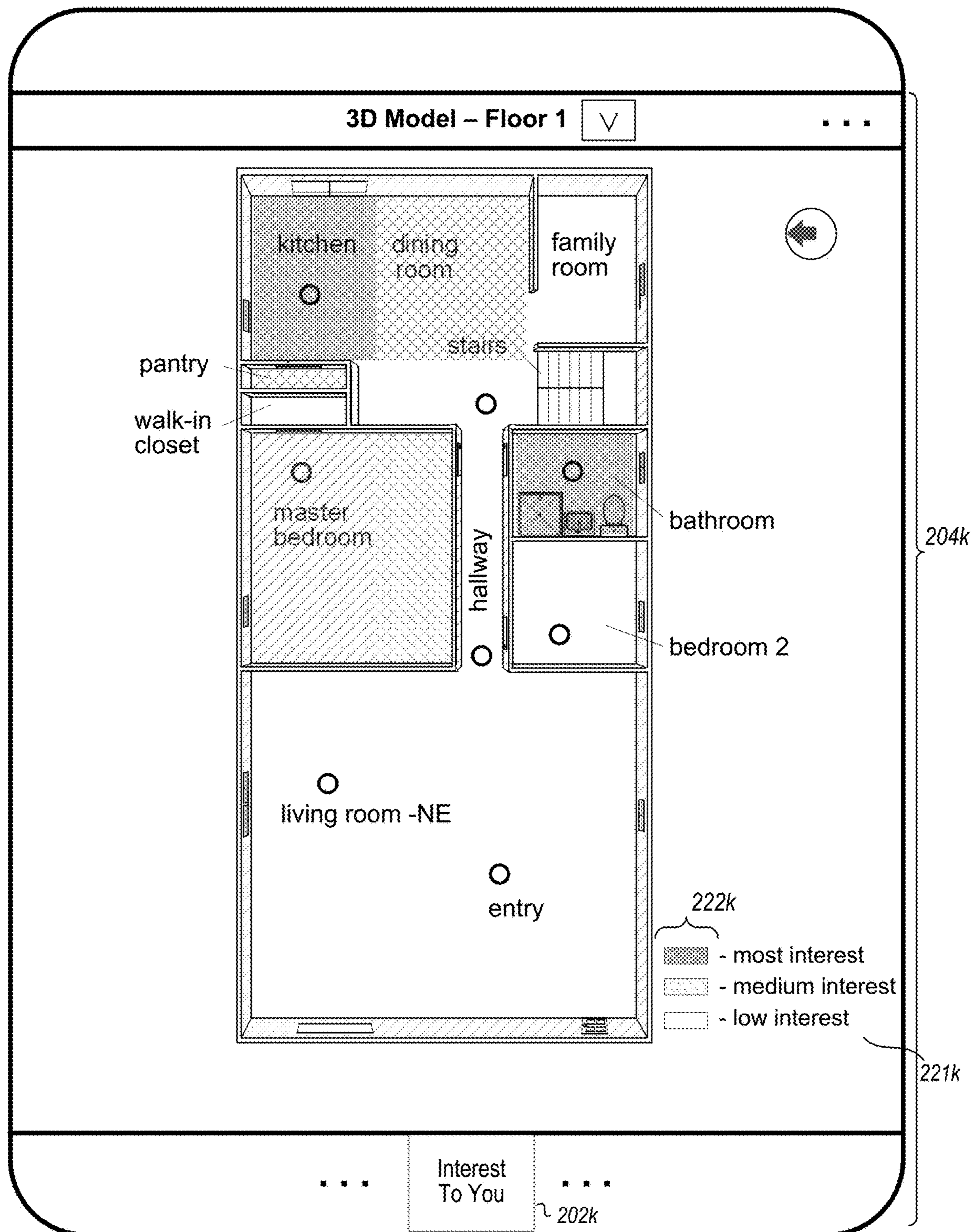


Fig. 2K

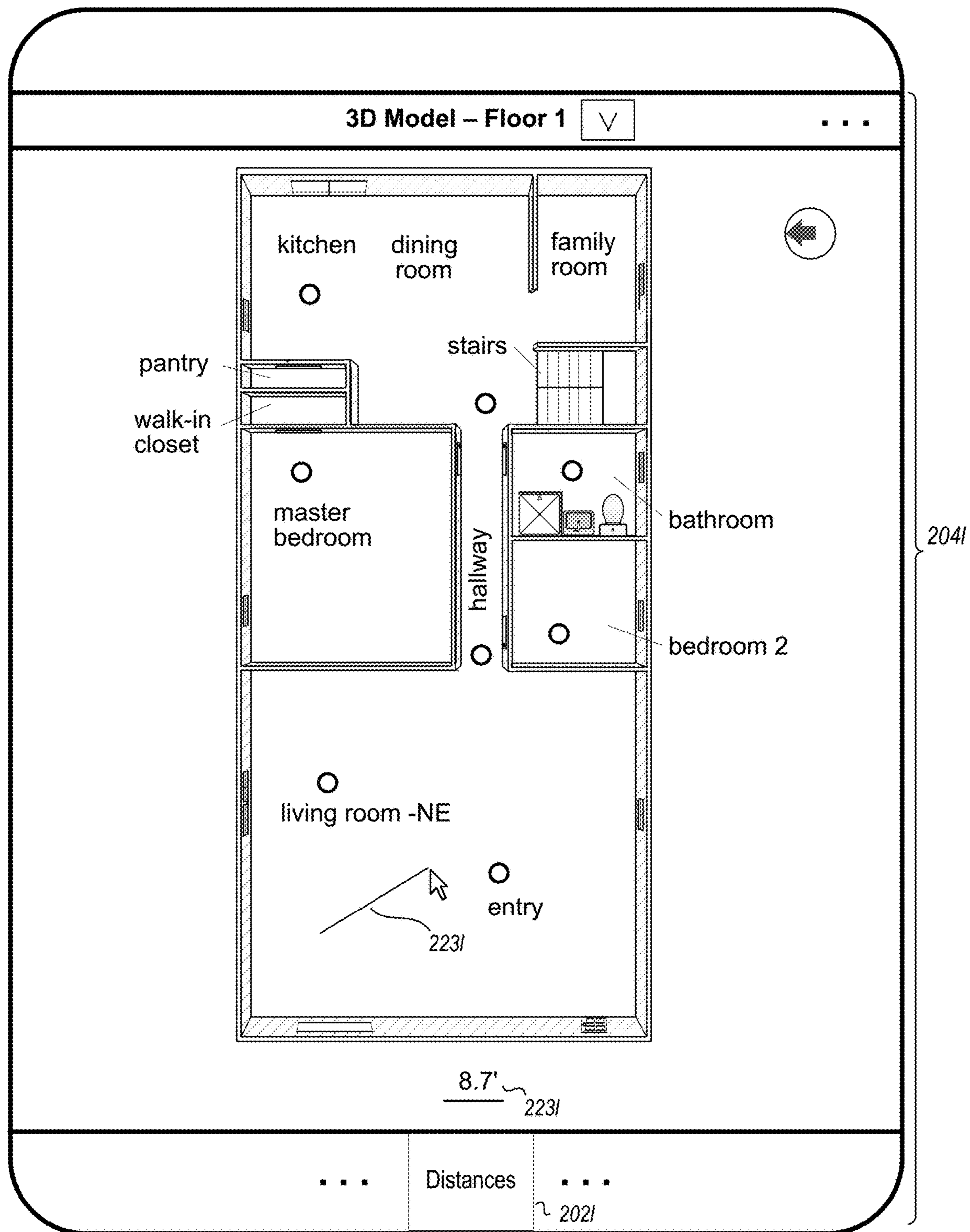


Fig. 2L

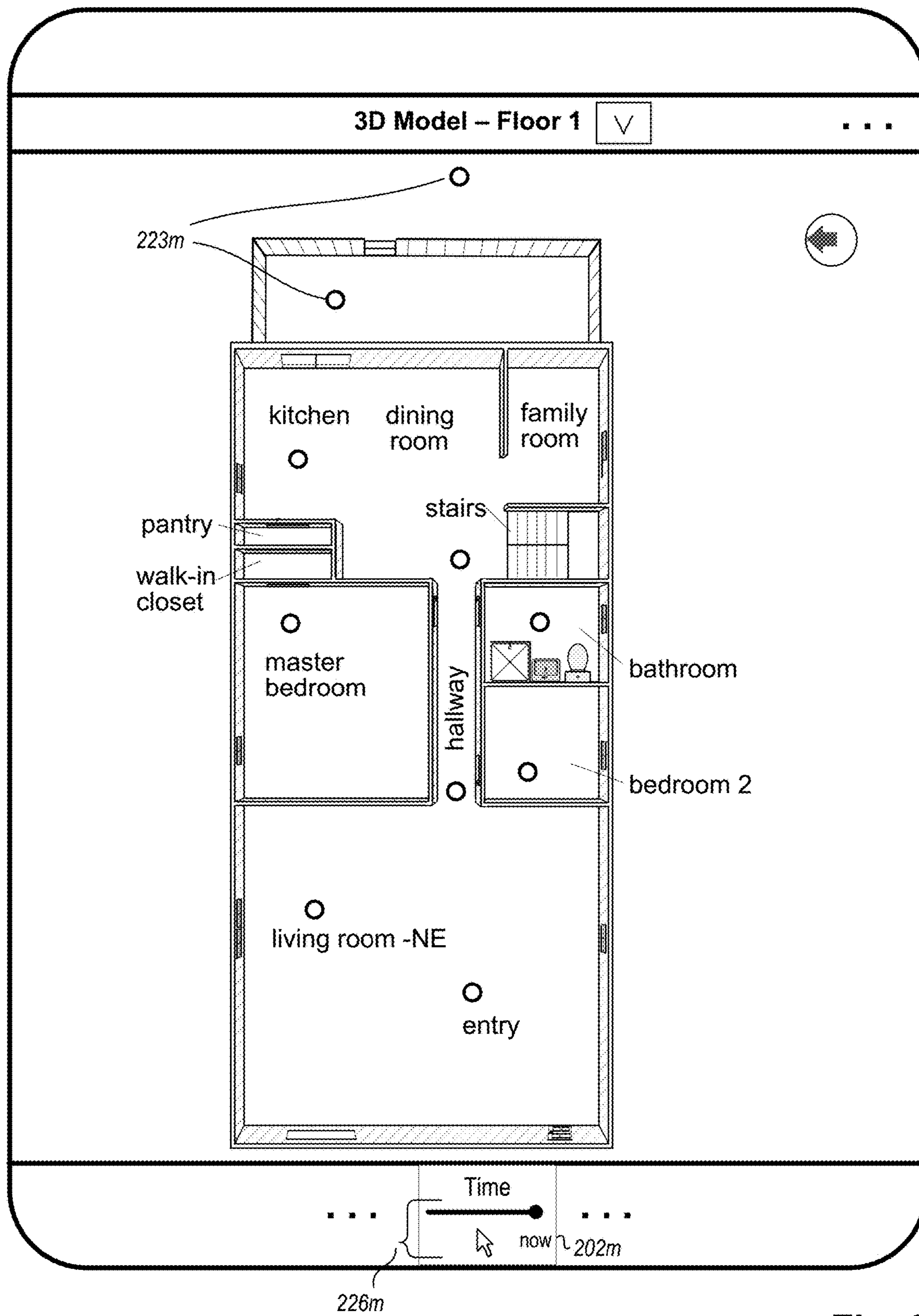


Fig. 2M

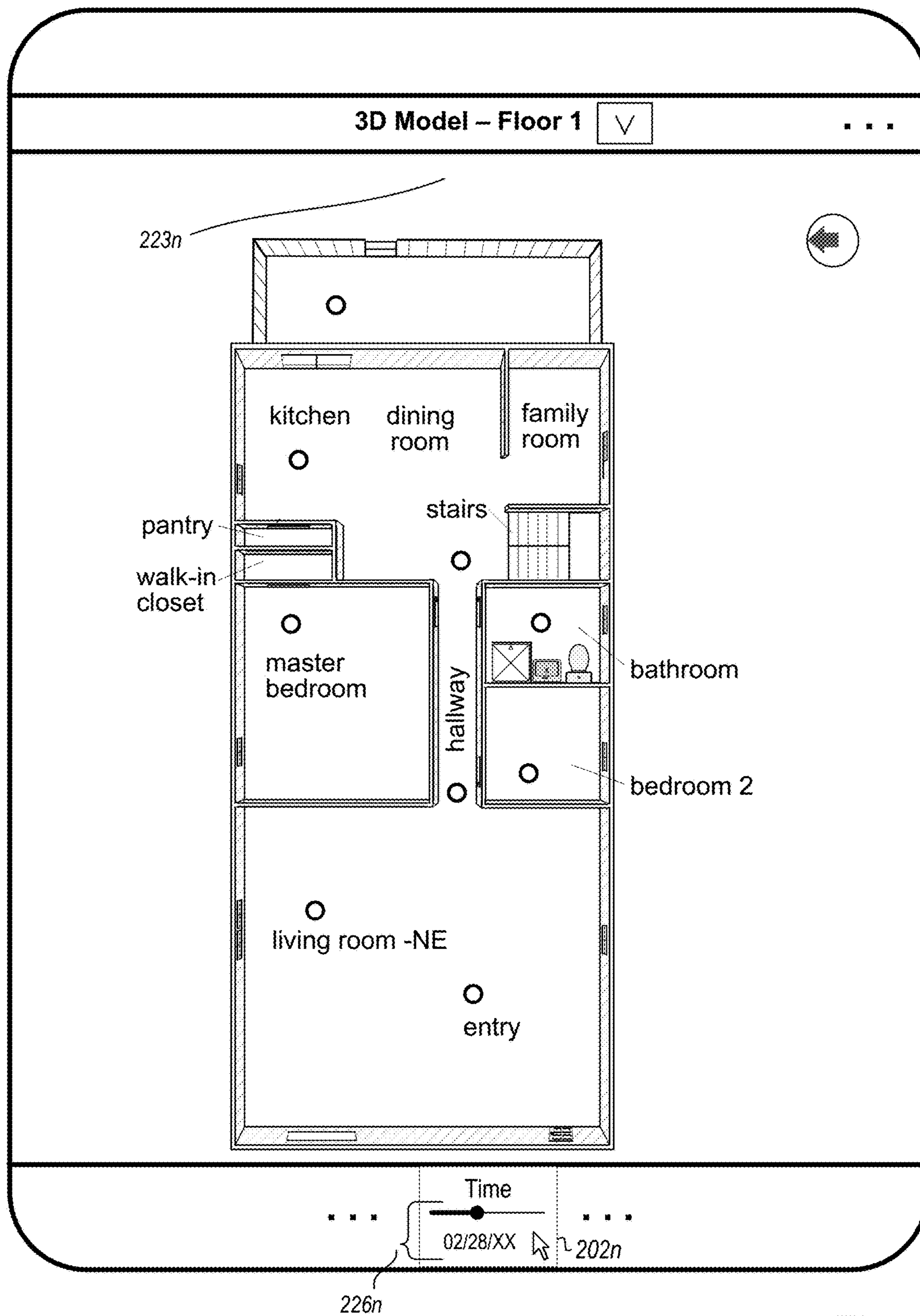


Fig. 2N

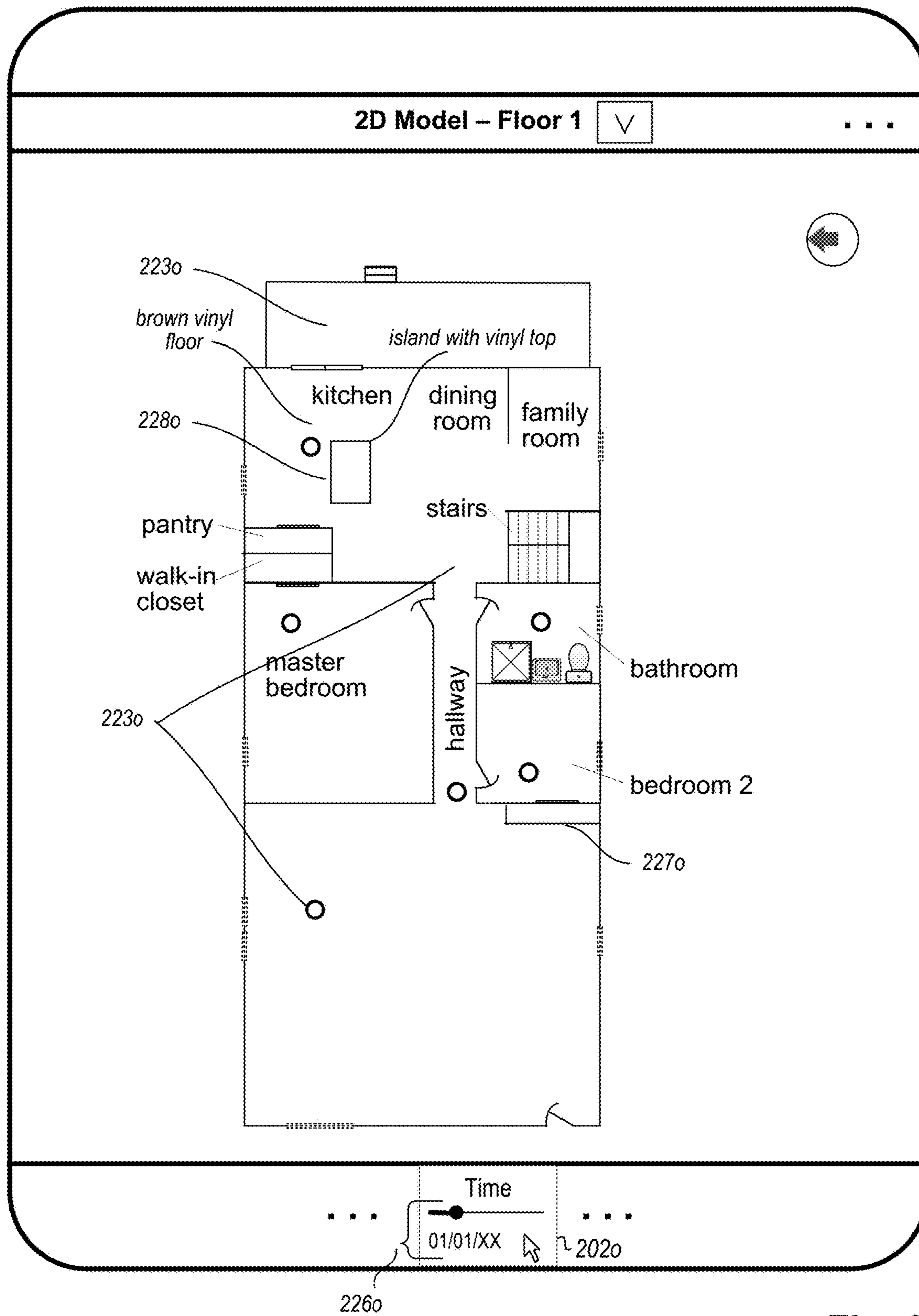


Fig. 2-0

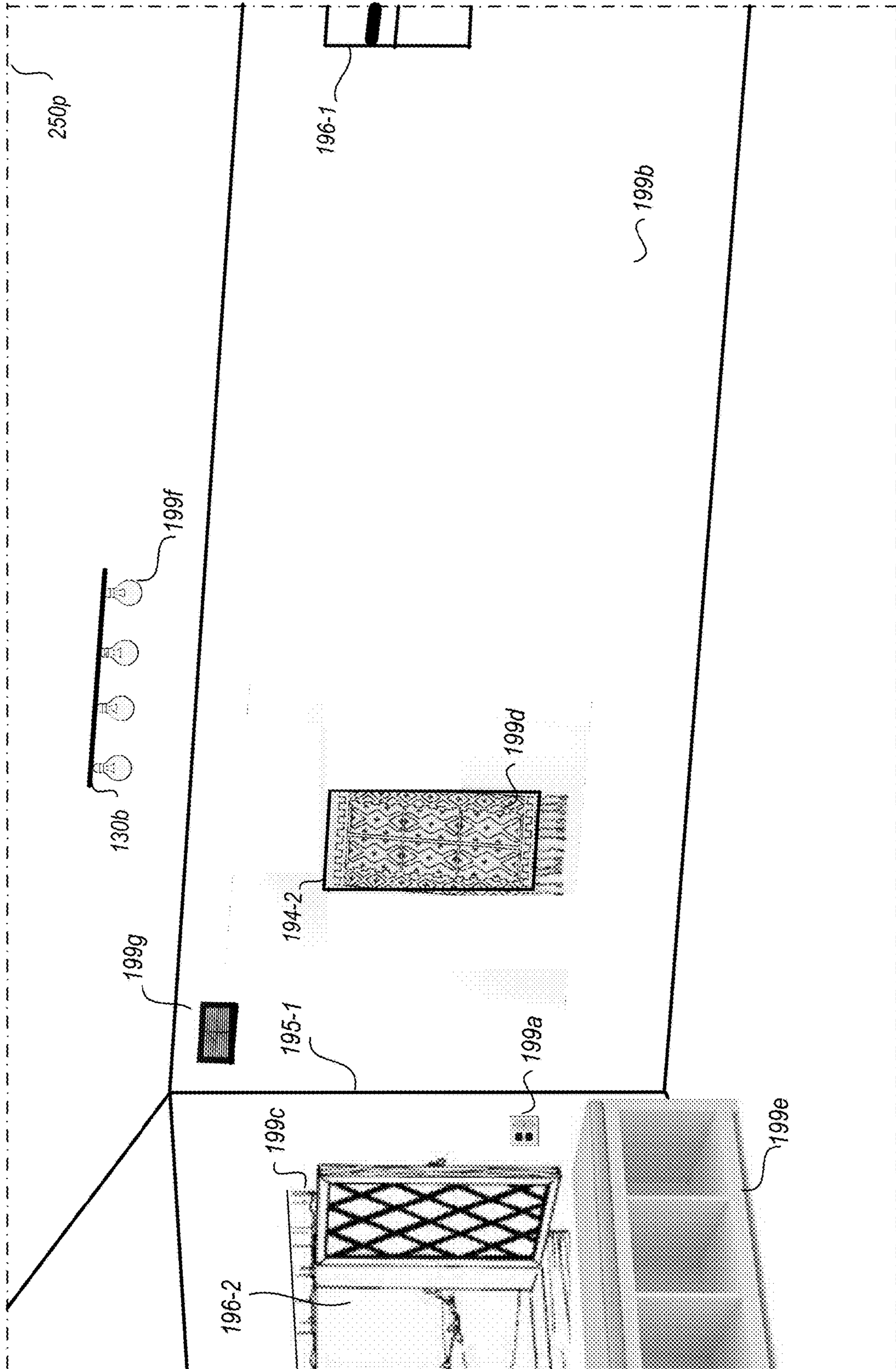


Fig. 2P

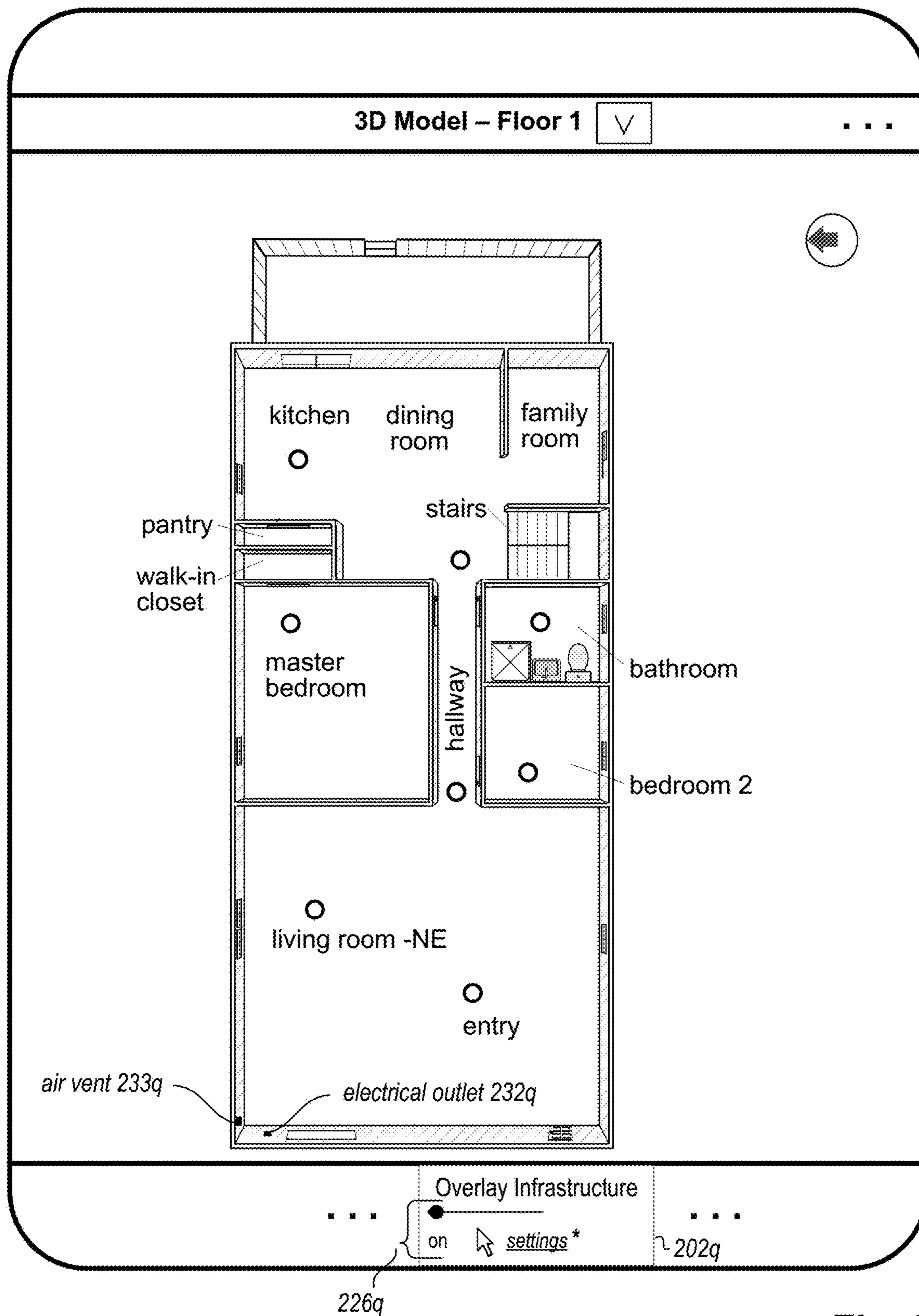


Fig. 2Q

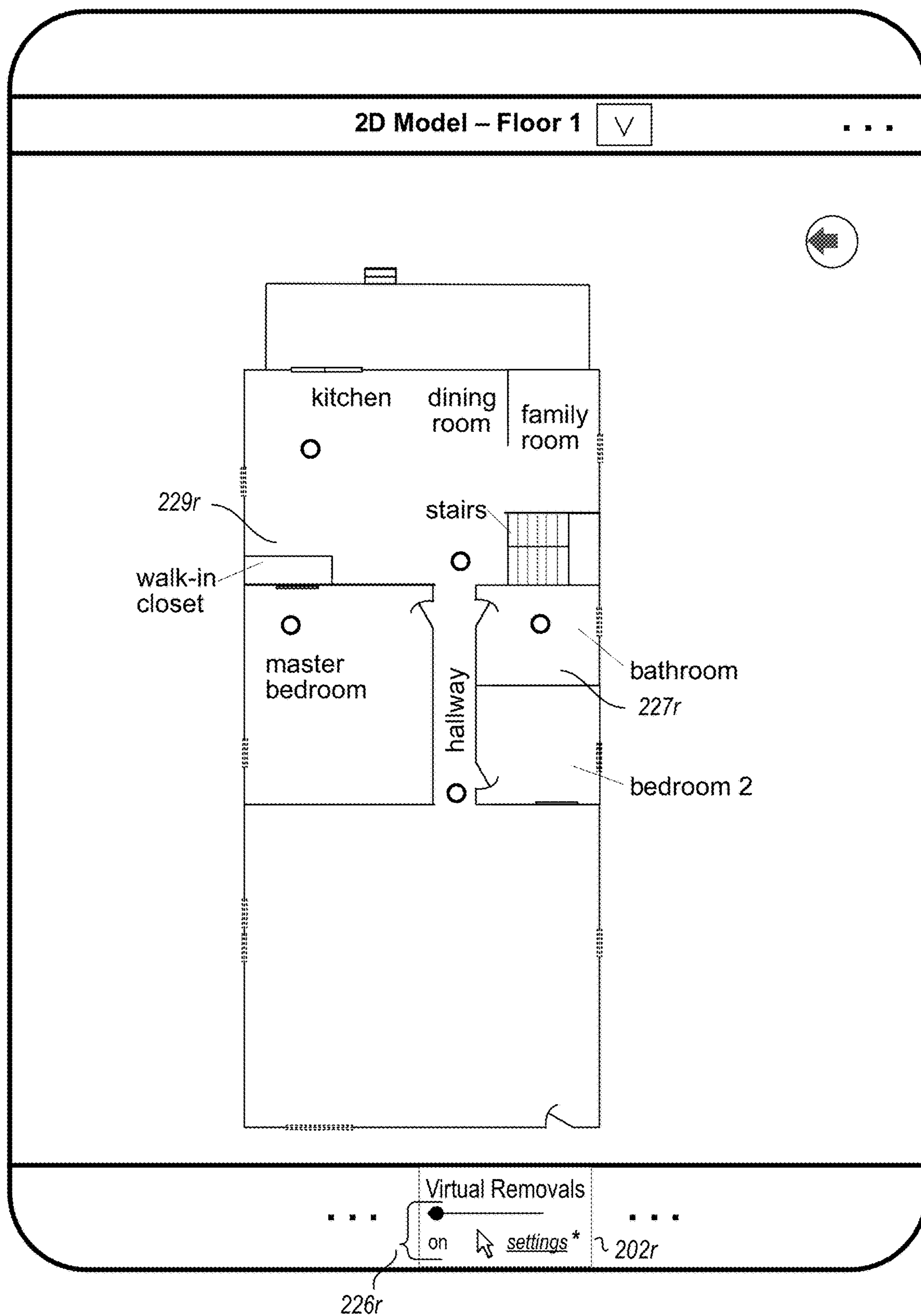


Fig. 2R

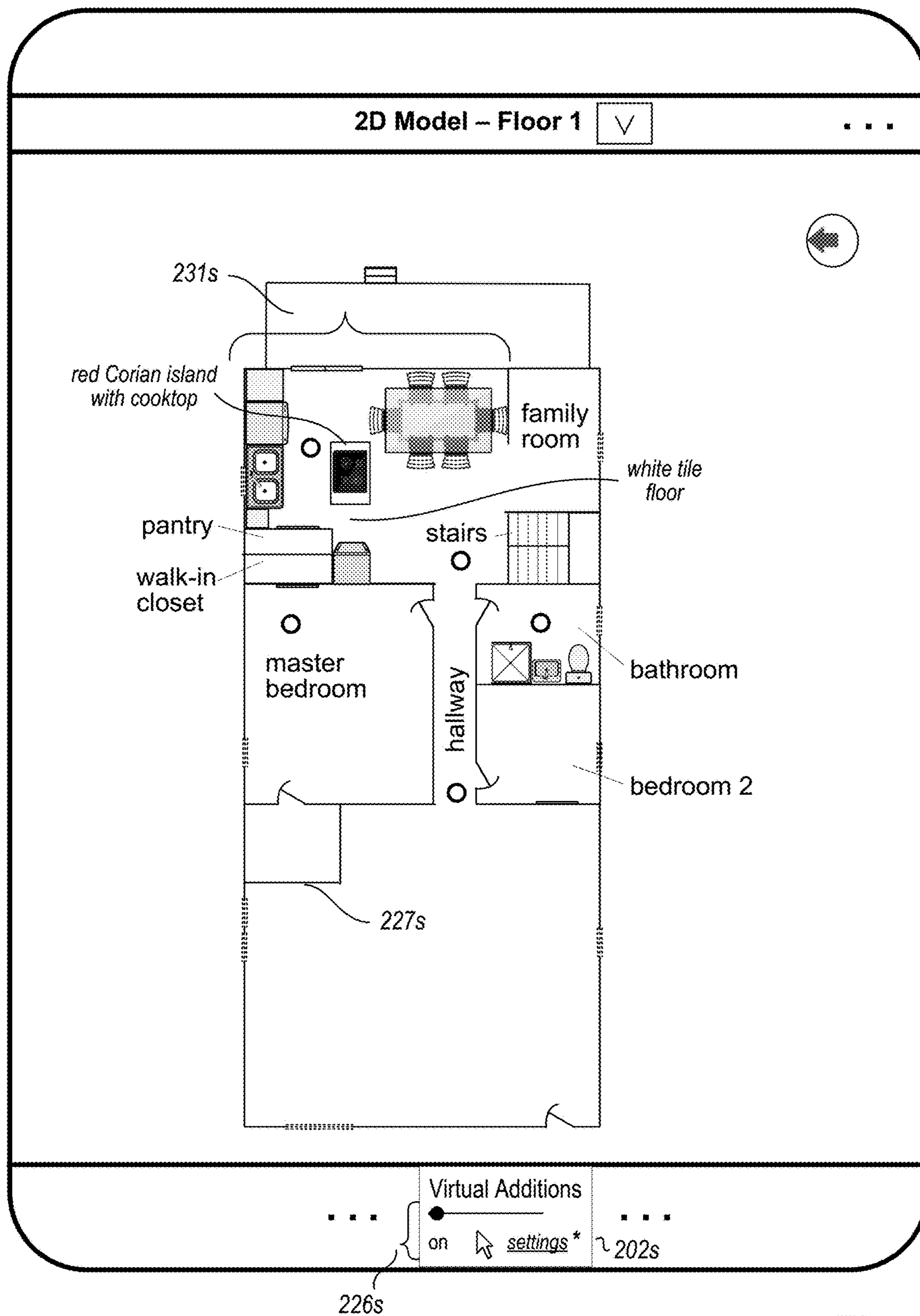


Fig. 2S

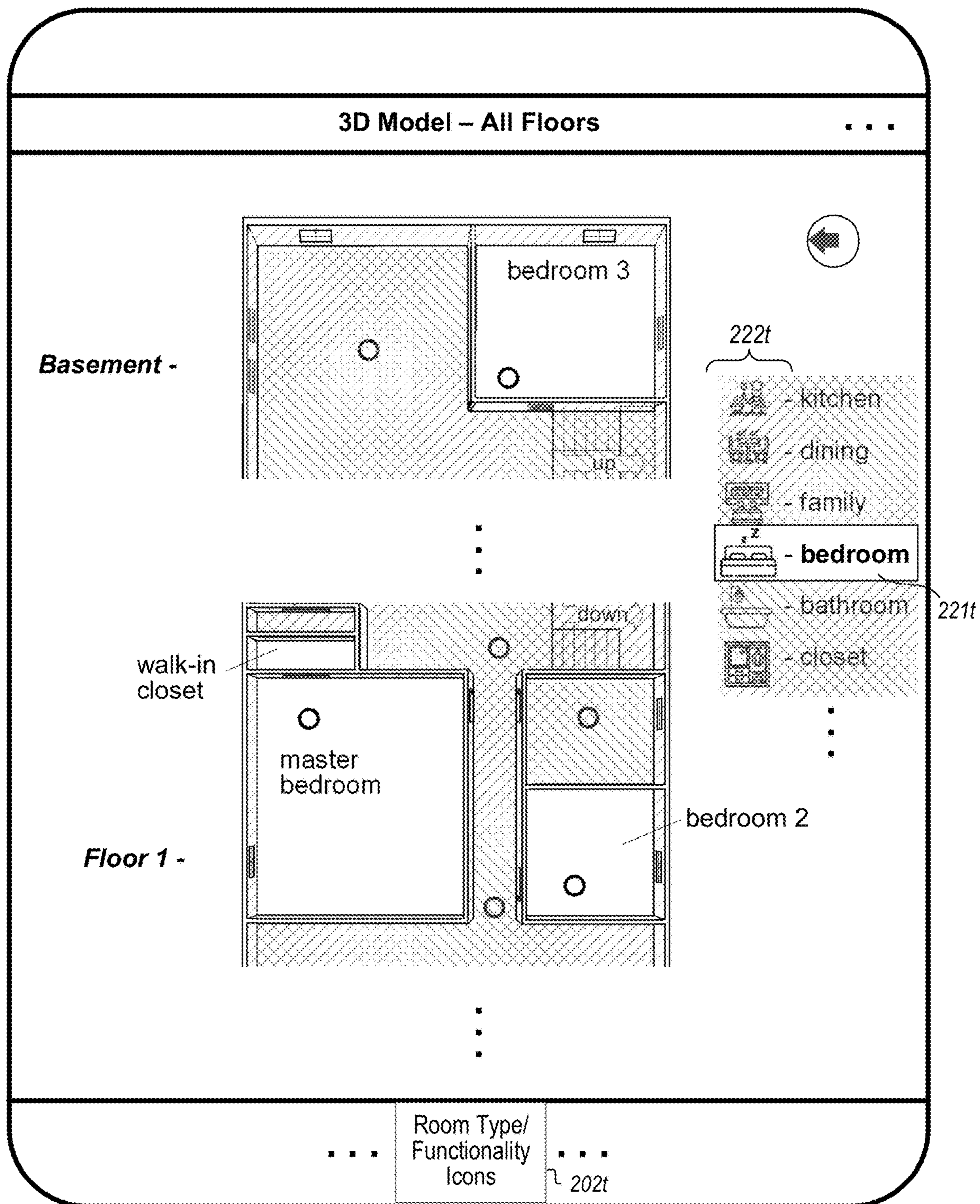


Fig. 2T

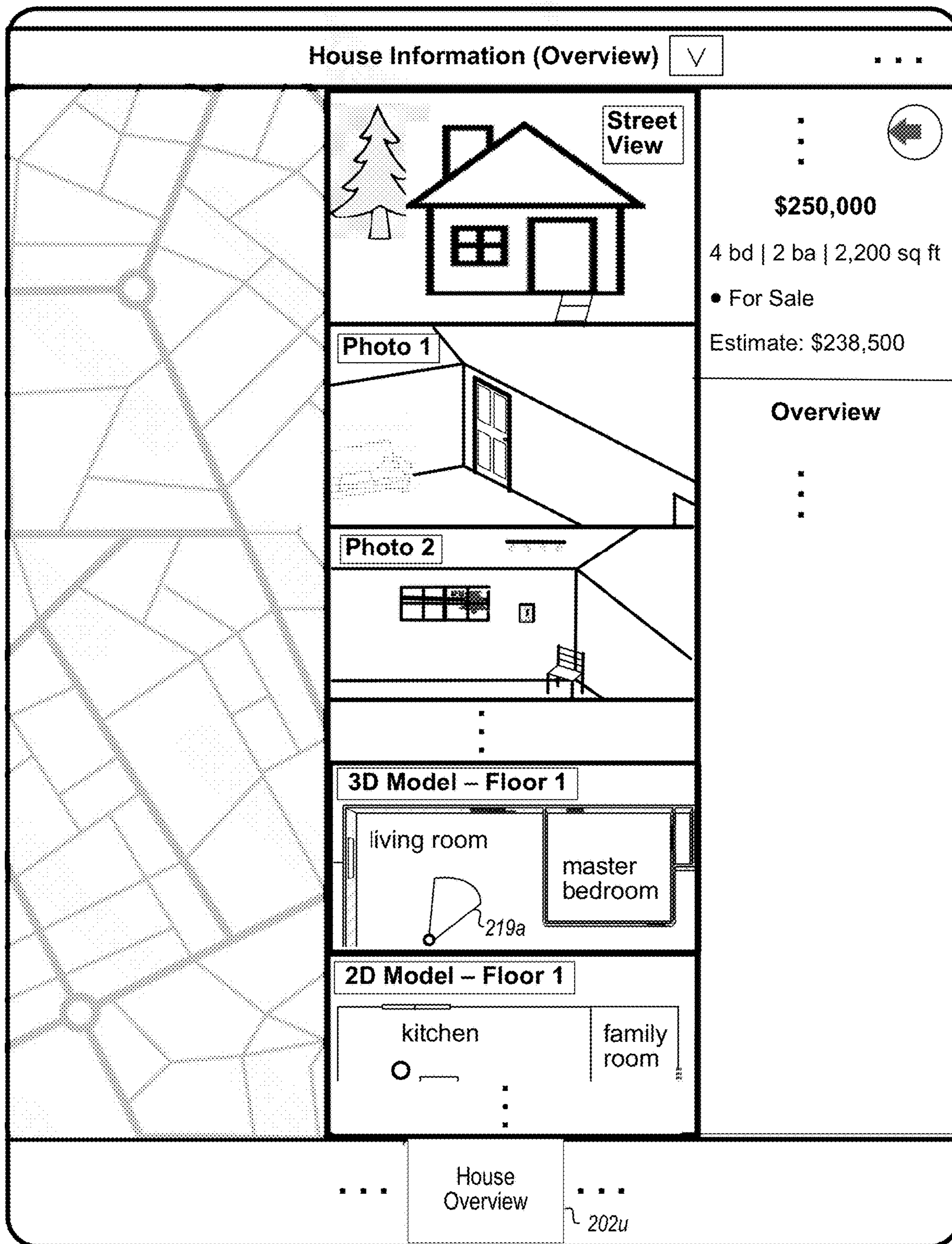


Fig. 2U

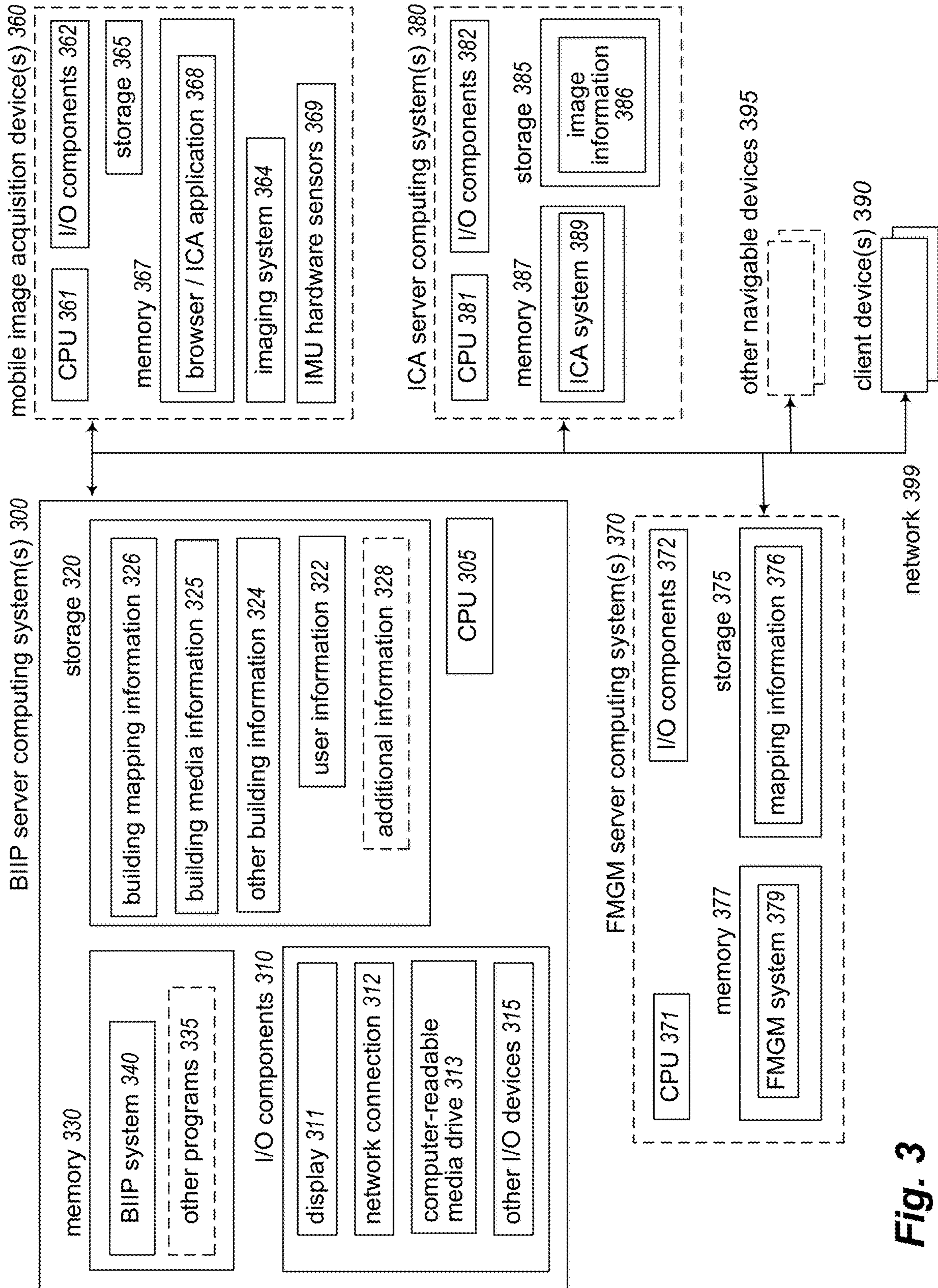


Fig. 3

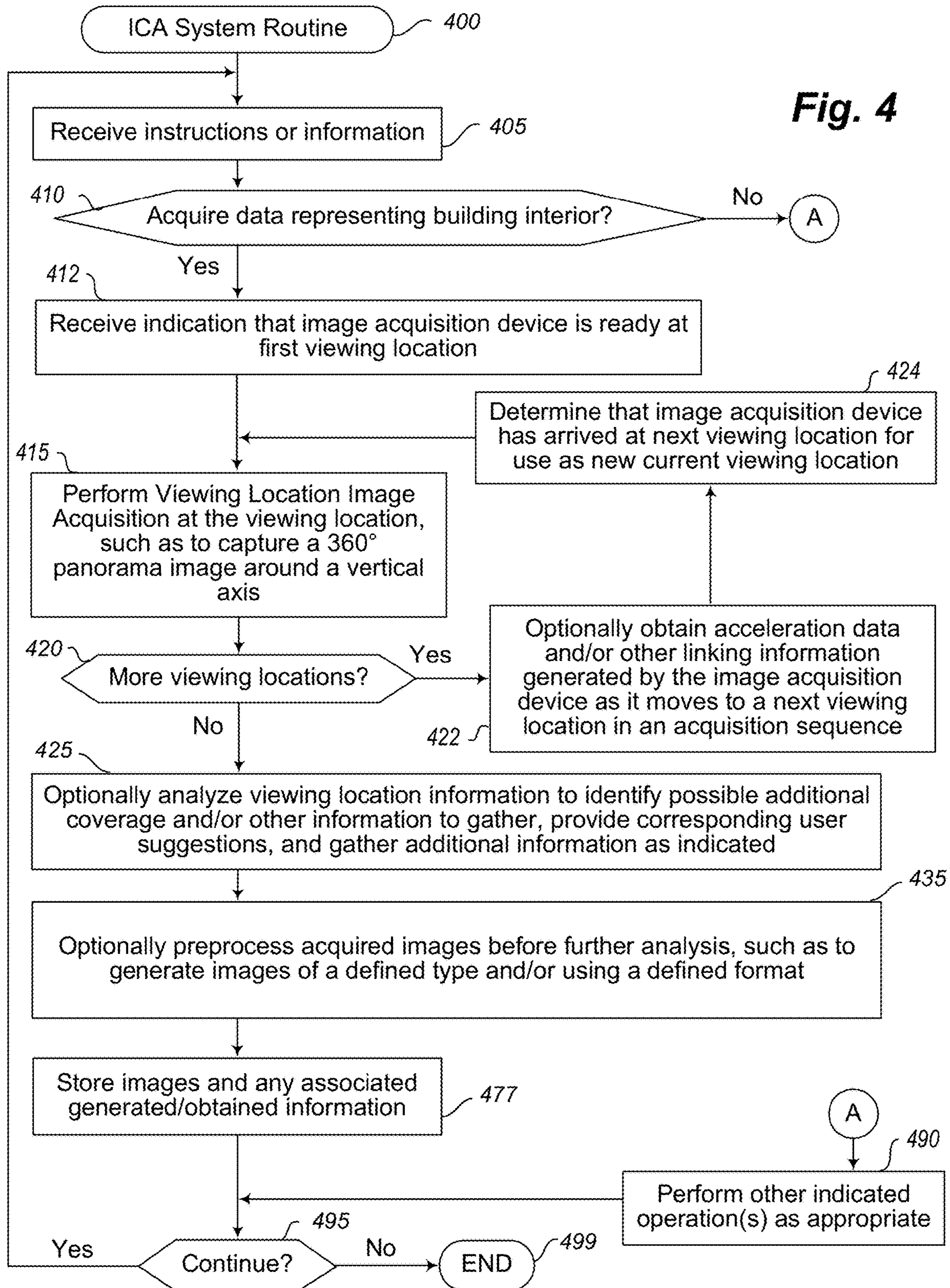


Fig. 5A

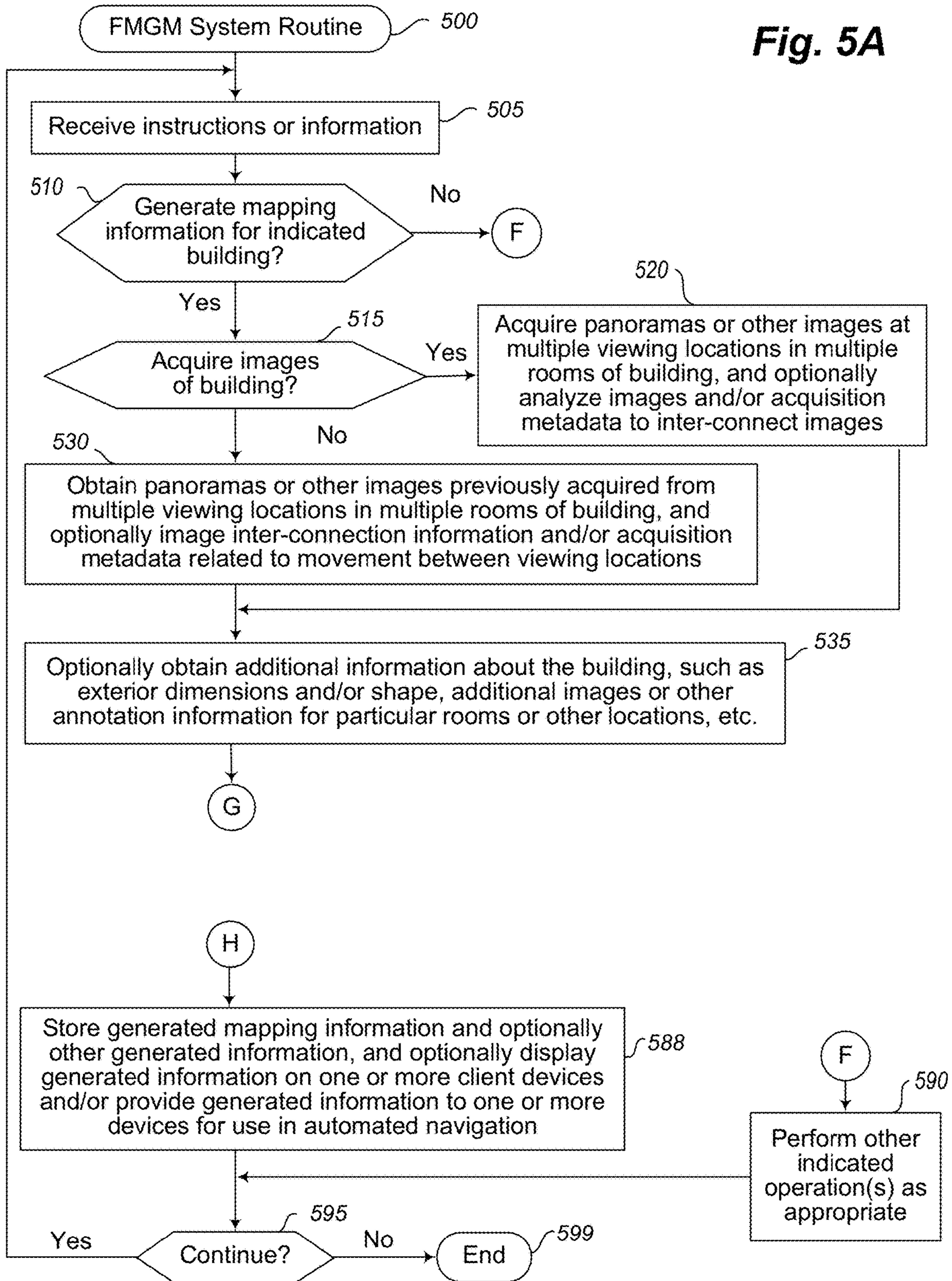


Fig. 5B

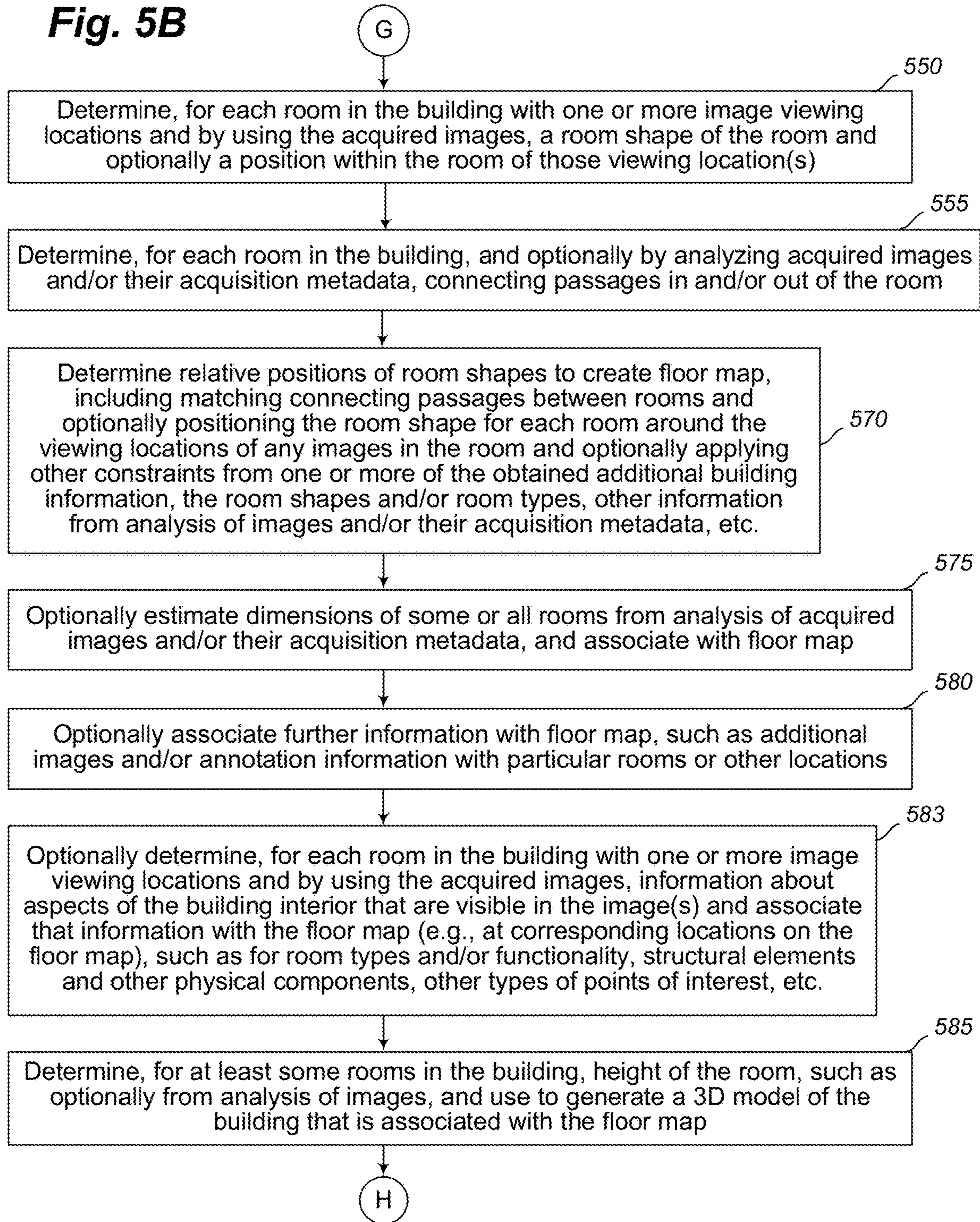
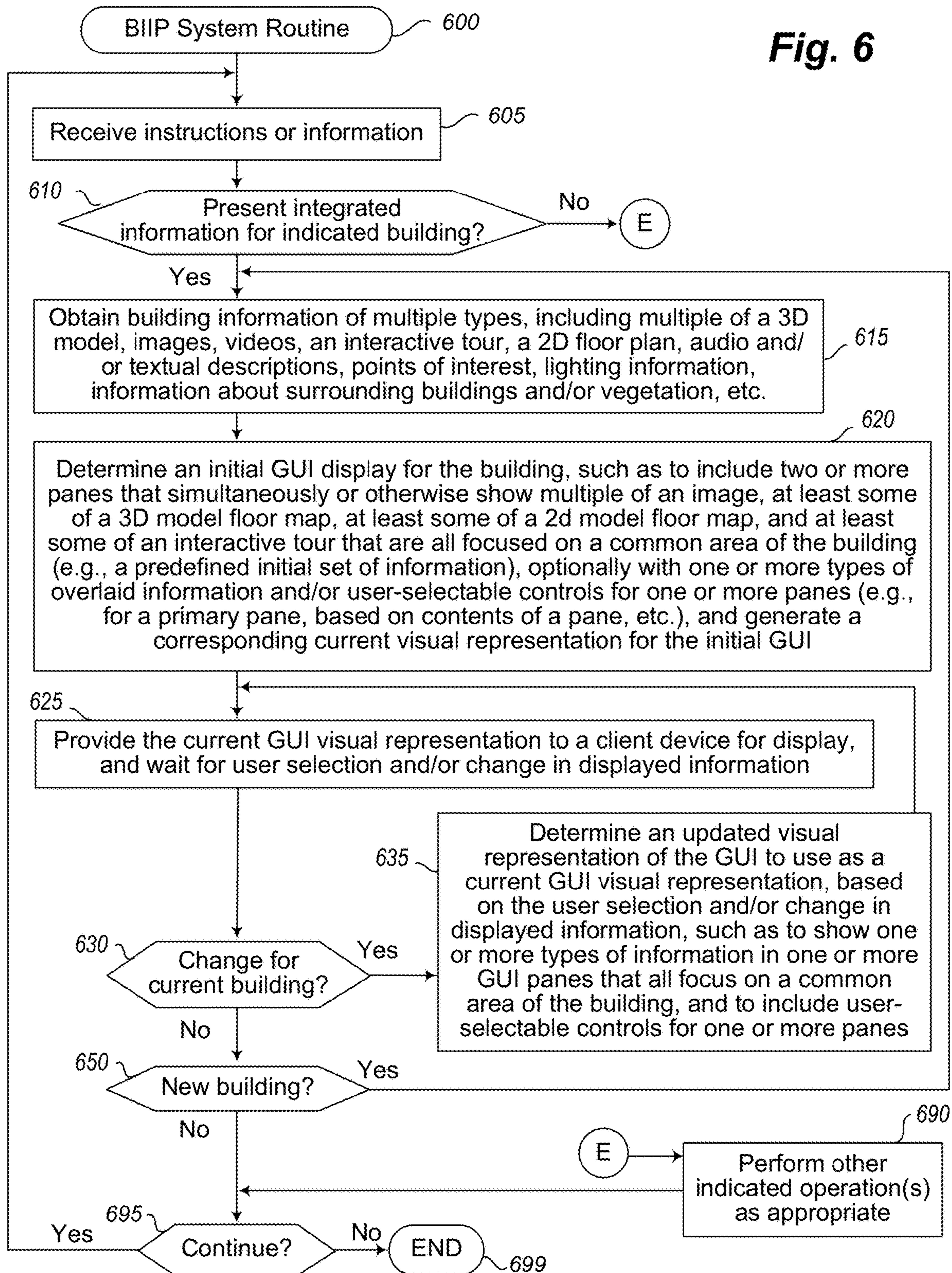


Fig. 6



PRESENTING BUILDING INFORMATION USING BUILDING MODELS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. Non-Provisional patent application Ser. No. 17/064,608, filed Oct. 7, 2020 and entitled “Presenting Integrated Building Information Using Building Models”, which is a continuation of U.S. Non-Provisional patent application Ser. No. 16/681,787, filed Nov. 12, 2019 and entitled “Presenting Integrated Building Information Using Three-Dimensional Building Models”, now U.S. Pat. No. 10,825,247, each of which is hereby incorporated by reference in their entirety.

TECHNICAL FIELD

The following disclosure relates generally to techniques for providing visual information of multiple types about a defined area, such as to present a computer model of an interior of an as-built building along with multiple other types of information about the building interior in an integrated manner (e.g., in a simultaneous and coordinated manner).

BACKGROUND

In various fields and circumstances, such as architectural analysis, property inspection, real estate acquisition and development, remodeling and improvement services, general contracting and other circumstances, it may be desirable to view information about the interior of a house, office, or other building without having to physically travel to and enter the building, including to determine actual as-built information about the building rather than design information from before the building is constructed. However, it can be difficult or impossible to effectively display visual information about building interiors to users at remote locations, such as to enable a user to fully understand the layout and other details of the interior, including under varying conditions.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A-1B are diagrams depicting an exemplary building interior environment and computing system(s) for use in embodiments of the present disclosure, including to generate and present information representing the building interior.

FIGS. 2A-2U illustrate examples of automated operations for presenting visual information that includes a 3D (three-dimensional) computer model of a building’s interior along with multiple additional types of information about the building interior in a simultaneous and coordinated manner.

FIG. 3 is a block diagram illustrating computing systems suitable for executing embodiments of one or more systems that perform at least some of the techniques described in the present disclosure.

FIG. 4 illustrates an example embodiment of a flow diagram for an Image Capture and Analysis (ICA) system routine in accordance with an embodiment of the present disclosure.

FIGS. 5A-5B illustrate an example embodiment of a flow diagram for a Floor Map Generation Manager (FMGM) system routine in accordance with an embodiment of the present disclosure.

FIG. 6 illustrates an example embodiment of a flow diagram for a Building Information Integrated Presentation (BIIP) system routine in accordance with an embodiment of the present disclosure.

DETAILED DESCRIPTION

The present disclosure describes techniques for using one or more computing devices to perform automated operations related to providing visual information of multiple types about a defined area, such as information about a building that is presented in an integrated manner and by using a computer model of the building’s interior. In at least some embodiments, the techniques include generating and presenting a GUI (graphical user interface) on a client device that includes a visual representation of a computer model of the building’s interior with one or more first types of information (e.g., in a first pane of the GUI), and to simultaneously present other types of related information about the building interior (e.g., in one or more additional separate panes of the GUI) that is coordinated with the first type(s) of information being currently displayed. The building may, for example, be a house, the computer model of the building’s interior may be a 3D (three-dimensional) or 2.5D (two and a half dimensional) or 2D (two-dimensional) floor plan representation that is generated after the house is built and that shows the house’s actual interior (e.g., types of building information such as walls; windows; doors; stairs; fireplaces; kitchen islands; cabinets; counters; lighting and/or plumbing fixtures and associated built-in elements such as sinks and showers/baths; built-in and/or moveable appliances, such as ovens, stoves, trash compactors, water heaters, HVAC equipment, refrigerators, washers, dryers, etc.; types of infrastructure, such as using wiring and/or piping, including electrical outlets, cable outlets, telephone outlets, air vents, sprinklers, speaker locations, security cameras, etc.; curtains and other furnishings; materials used for surfaces such as kitchen countertops, wallpaper, paint, floor coverings, etc.; furniture; fire extinguishers; etc.), and the types of presented information about the building interior may include visualizations of the computer model (e.g., 3D and/or 2D and/or 2.5D), panorama images (e.g., 360° panorama images with 360° of coverage around a vertical axis), 2D (two-dimensional) perspective photos and other images, videos, an interactive tour of inter-connected viewing/capture locations, and various other types of information. Additional details are included below regarding the automated operations of the computing device(s) involved in the generating and presenting of the various types of coordinated information about a building’s interior, and some or all of the techniques described herein may, in at least some embodiments, be performed at least in part via automated operations of a Building Information Integrated Presentation (“BHIP”) system, as discussed further below.

The types of information that are presented about a building’s interior (and in some cases surroundings) may have various forms in various embodiments, and may be acquired in various manners. In addition, at least some of those types of information may be associated with corresponding positions in a computer model of the building (e.g., a 3D model with full height information represented; a 2.5D model with partial representations of height represented; a 2D floor map model without height represented, such as using an orthographic top view or other overhead schematic view; etc.). As one example, types of additional information about a building may include one or more of the following, and may be associated with locations from which the

information was captured and/or locations that are shown or otherwise represented in the captured information: photos or other images (e.g., 2D perspective images, 360 panorama images and/or other panorama images, etc.), such as to be associated with viewing locations (also referred to at times as ‘capture locations’ or ‘recording locations’ or ‘viewing/capture locations’) within the rooms of the building where they were taken; video recordings, such as to each include a sequence of multiple images and to be associated with viewing locations within the rooms of the building where they were taken; textual and/or audio annotations or other descriptions of particular points of interest (POIs) in the building’s rooms or other locations, including types of building information automatically identified via analysis of visual data from acquired images for the building; other audio information, such as recordings of ambient noise that are associated with recording locations within the rooms of the building where they were taken; a time-lapse or other accelerated video and/or animation of an area in or around a home, such as from a front door and/or front window of a house to show traffic or other information over a first period of time (e.g., 1 hour, 4 hours, 8 hours, 12 hours, 24 hours, etc.) that is presented over a shorter period of time (e.g., 10 seconds, 30 seconds, 1 minute, 5 minutes, 10 minutes, etc.); other external information from an environment surrounding the building, such as about nearby buildings and/or vegetation (e.g., as identified from satellite or other external images of the building, such as taken from the building and/or from a nearby street or yard; as identified from data in one or more external databases or other information sources, such as street maps or other government records; etc.), whether by displaying the actual images or by generating and displaying visual representations of particular external elements that are identified and modeled from images or other external information sources; lighting information for an interior of a building and/or its surroundings, such as simulated lighting for one or more rooms of a building (e.g., to simulate daylight entering the one or more rooms at one or more defined times, to show actual lighting from interior lights in the one or more rooms at one or more defined times; etc.); in-room images for a room that are projected on the walls of the room shown in the model; user-generated and/or ‘crowd-sourced’ information provided by one or more end users about the building, such as interior and/or exterior images, descriptions, questions, answers, etc. that are associated with particular rooms or locations within rooms; estimated scale information such as room width, length and/or height dimensions; geographical location and/or orientation information for the building; a 2D (two-dimensional) floor map of the building interior, such as using an overhead schematic view (e.g., an orthographic top view); etc. Additional details are included elsewhere herein regarding types of information that may be presented about a building for a house or other building in a displayed GUI, such as in a coordinated and simultaneous manner and/or based at least in part on a generated computer model of the building.

In addition, the automated operations may include controlling how multiple types of information are presented in various embodiments about a building’s interior (and in some cases, the building’s surroundings), such as in a simultaneous and coordinated manner, a sequential manner (e.g., as selected by a user), etc. In at least some embodiments, such automated operations include presenting a GUI with multiple panes that are simultaneously displayed, and with each pane including information of a different type that are all related to a common location or area in the building interior or other common aspect/feature of the building

interior. As one non-exclusive example, a first pane may be displaying a photo taken in a room of the building to show at least some of that room, a second pane may be displaying a portion of a 3D computer model of the building that includes the room, and a third pane may be displaying a video taken within the room or a part of an interactive tour of the building that includes one or more viewing locations situated within the room—in addition, in at least some embodiments, one of the panes may be a primary pane (e.g., that is larger than other secondary panes, and/or that has user-selectable controls via which the user may interact with the content shown in that pane in various manners), and the GUI may further enable the user to easily switch content between the primary pane and one of the secondary panes, or to otherwise change information shown in one or more of the panes. In other embodiments and/or situations, only a single pane may be displayed, in which multiple types of information about a building may be sequentially displayed, such as in response to selections by a user.

Various user-selectable controls may also be displayed in or otherwise associated with one or more of the displayed panes (e.g., with the primary pane, and optionally in a contextual manner based on the type of content displayed in the primary pane) and provide functionality to make various types of modifications to the displayed information, such as one or more of the following: to change the contents of a secondary pane to a primary pane; to change the contents of the primary pane or a secondary pane to another type of information that is not currently displayed, with the new information of the other type similarly being coordinated with the content currently displayed in the other panes; to change the contents of a single displayed pane with at least one type of information about a building, such as to another type of information for the building that is not currently displayed, to information about another building, etc.; to toggle on and off one or more additional types of information that are overlaid on the contents of a pane, such as textual and/or audio descriptions, information about points of interest (including types of building information automatically identified via analysis of visual data from acquired images for the building), questions and/or answers, lighting information, etc.; to add user-specified content (e.g., a photo, a description, a question, etc.) to the content of a particular pane and/or to a location of the building shown in that pane; etc. Additional details are included elsewhere herein regarding the presentation of one or more types of information about a building, including about types of user-selectable controls and other user selections in a displayed GUI, such as for multiple types of information about a building that are displayed in a simultaneous and coordinated manner.

The described techniques provide various benefits in various embodiments, including to use 3D models and/or 2.5D models and/or 2D floor map models of multi-room buildings and other structures (e.g., that are generated from images acquired in the buildings or other structures) to display various types of information about building interiors, such as in a coordinated and simultaneous manner with other types of related information, including to use information about the actual as-built buildings (e.g., internal structural components and/or other interior elements, nearby external buildings and/or vegetation, actual building geographical location and/or orientation, actual typical weather patterns, etc.) rather than using information from plans on how the building is designed and should theoretically be constructed. Such described techniques may further provide benefits in at least some embodiments for allowing improved automated navigation of a building by mobile

devices (e.g., semi-autonomous or fully-autonomous vehicles) via use of information of various types, including to significantly reduce their computing power used and time used to attempt to otherwise learn a building's layout. In addition, in some embodiments the described techniques may be used to provide an improved GUI in which an end user may more accurately and quickly obtain information about a building's interior (e.g., for use in navigating that interior, such as via a virtual interactive tour), including in response to search requests, as part of providing personalized information to the end user, as part of providing value estimates and/or other information about a building to an end user, etc. Various other benefits are also provided by the described techniques, some of which are further described elsewhere herein.

For illustrative purposes, some embodiments are described below in which specific types of information are acquired, generated, used and/or presented in specific ways for specific types of structures and by using specific types of devices—however, it will be understood that the described techniques may be used in other manners in other embodiments, and that the invention is thus not limited to the exemplary details provided. As one non-exclusive example, while various types of information related to house interiors may be used in some situations, it will be appreciated that one or more of such information types may be similarly used in other embodiments for other types of buildings (or other structures or layouts) separate from houses and/or for other parts of a house or other building (e.g., for external walls; surrounding yards; surrounding supplemental structures, such as a garage, shed, barn, etc.; roofs; etc.). As another example, while various types of information for models of houses or other buildings may be used for display to assist viewers in navigating the buildings or otherwise understanding the buildings' interiors, at least some such types of information may be used in other manners in other embodiments. In addition, the term “building” refers herein to any partially or fully enclosed structure, typically but not necessarily encompassing one or more rooms that visually or otherwise divide the interior space of the structure—non-limiting examples of such buildings include houses, apartment buildings or individual apartments therein, condominiums, office buildings, commercial buildings or other wholesale and retail structures (e.g., shopping malls, department stores, warehouses, etc.), etc. The term “acquire” or “capture” as used herein with reference to a building interior, viewing location, or other location (unless context clearly indicates otherwise) may refer to any recording, storage, or logging of media, sensor data, and/or other information related to spatial and/or visual characteristics of the building interior or subsets thereof, such as by a recording device or by another device that receives information from the recording device. In addition, various details are provided in the drawings and text for exemplary purposes, but are not intended to limit the scope of the invention. For example, sizes and relative positions of elements in the drawings are not necessarily drawn to scale, with some details omitted and/or provided with greater prominence (e.g., via size and positioning) to enhance legibility and/or clarity. Furthermore, identical reference numbers may be used in the drawings to identify similar elements or acts.

FIG. 1A is an example block diagram of various computing devices and systems that may participate in the described techniques in some embodiments. In particular, an Interior Capture and Analysis (“ICA”) system (e.g., a system 160 that is executing on one or more server computing systems 180, and/or a system provided by application 155 executing

on one or more mobile image acquisition devices 185) has acquired images 165 (e.g., 360° spherical panorama images in equirectangular format), such as with respect to one or more buildings or other structures (not shown in FIG. 1A), and a Floor Map Generation Manager (“FMGM”) system (e.g., a system 160 that is executing on one or more server computing systems 180, and/or a system provided by application 157 executing on one or more mobile image acquisition devices 185) has used the acquired images 165 and optionally other information to generate one or more 2D floor maps 165 and/or computer models 165 (e.g., 3D and/or 2.5D models) for the one or more buildings or other structures. FIG. 1B shows one example of acquisition of panorama images for a particular house at multiple capture/viewing locations 210, and FIG. 2A—(e.g., 210A-210J) within the house interior and exterior (e.g., with location 210I on an external area 118, such as a deck or patio, and location 210J in another external area, such as a patio or backyard or garden) 2U illustrate additional details about using a computer model generated from such panorama images to control how multiple types of information are presented about the house, such as in a simultaneous and coordinated manner, and as discussed further below.

A BHP (Building Information Integrated Presentation) system 140 is further executing on one or more server computing systems to use building models, maps and images 145 (e.g., acquired from information 165) and/or other mapping-related information or associated information (not shown) in order to control the presentation of multiple types of information (including such building models 145) about the house or other building, such as in a simultaneous and coordinated manner. As part of doing so, the BHP system may receive requests or instructions or other information via computer network(s) 170 from end users of building information viewer client computing devices 175 about types of information to include, before generating and providing such information for display on the client computing devices 175, and may further optionally obtain and use supporting information in some embodiments supplied by BHP system operator users via computing devices 105 and intervening computer network(s) 170 to configure or modify operations of the BHP system. Additional details related to the automated operation of the BHP system are included elsewhere herein, including with respect to FIGS. 2A-2U and FIG. 6. In some embodiments, the ICA system(s) 160 and/or FMGM system(s) 160 and/or BHP system 140 may execute on the same server computing system(s), such as if two or more of the systems are operated by a single entity or are otherwise executed in coordination with each other (e.g., with some or all functionality of such systems integrated together into a larger system), while in other embodiments the BHP system may instead operate separately from such an ICA system (e.g., without an ICA system by instead obtaining panorama images or other images from one or more external sources) and/or may instead operate separately from such an FMGM system (e.g., without an FMGM system by instead obtaining 2D floor maps or other computer models of buildings from one or more external sources).

Various components of the mobile image acquisition device 185 are illustrated in FIG. 1A, including a browser 162 and/or an ICA system application 155 and/or an FMGM system application 157 that are executed in memory 152 of the device 185 by one or more hardware processors 132, and including one or more imaging systems 135 to acquire visual data. The illustrated embodiment of mobile device 185 further includes one or more sensor modules 148 that

include a gyroscope **148a**, accelerometer **148b** and compass **148c** in this example (e.g., as part of one or more IMU units, not shown separately, on the mobile device), optionally a GPS (or Global Positioning System) sensor **137** or other position determination sensor (not shown in this example), a display system **142**, a control system **147** to control acquisition of images (e.g., to rotate the mobile device), etc.—while not illustrated in this example, in some embodiments the device **185** may further have or be associated with one or more depth sensors or other distance-sensing devices that provide depth data to surrounding objects, while in other embodiments the device **185** does not have any such associated depth sensors or other distance-sensing devices. Other computing devices/systems **105**, **175** and **180** may include various hardware components and stored information in a manner analogous to mobile device **185**, but are not shown in this example for the sake of brevity, although some related further details are discussed below with respect to FIG. 3.

In the example of FIG. 1A, the ICA system may perform automated operations involved in acquiring multiple images at multiple associated viewing locations (e.g., in multiple rooms or other locations within a building or other structure and optionally around some or all of the exterior of the building or other structure), such as using visual data acquired via the mobile device(s) **185**, and for subsequent use in generating and providing a representation of an interior of the building or other structure. For example, in at least some such embodiments, such techniques may include using one or more mobile devices (e.g., a camera having one or more fisheye lenses or other lenses that simultaneously capture 360° horizontally around a vertical axis, such as to produce a 360° spherical panorama image without rotation; a camera having one or more fisheye lenses or other lenses that capture less than 360° horizontally at a given time, and that is mounted on a rotatable tripod or otherwise having an automated rotation mechanism to enable 360° image capture over a period of time corresponding to the rotation; a smart phone held and moved by a user, such as to rotate the user's body and held smart phone in a 360° circle around a vertical axis; a camera held by or mounted on a user or the user's clothing; a camera mounted on an aerial and/or ground-based drone or robotic device; etc.) to capture data from a sequence of multiple viewing locations within multiple rooms of a house (or other building), and to optionally further capture data involved in movement or travel between some or all of the viewing locations for use in linking the multiple viewing locations together, but without having distances between the viewing locations being measured or having other measured depth information to objects in an environment around the viewing locations (e.g., without using any depth-sensing sensors). After a viewing location's information is captured, the techniques may include producing a panorama image from that viewing location (e.g., a 360° panorama image that includes 360° of horizontal coverage around a vertical axis, a 360° spherical panorama image that further shows the surrounding room in an equirectangular format, another type of panorama image in another format, etc.), and then providing the panorama images for subsequent use by an FMGM system and/or BHP system. Additional details related to embodiments of a system providing at least some such functionality of an ICA system are included in U.S. Non-Provisional patent application Ser. No. 16/236,187, filed Dec. 28, 2018 and entitled "Automated Control Of Image Acquisition Via Use Of Acquisition Device Sensors"; in U.S. Non-Provisional patent application Ser. No. 16/190,162, filed Nov. 14, 2018 and entitled "Automated Mapping Information Generation From

Inter-Connected Images"; and in U.S. Non-Provisional patent application Ser. No. 15/649,434, filed Jul. 13, 2017 and entitled "Connecting And Using Building Interior Data Acquired From Mobile Devices" (which includes disclosure of a BICA system that is one example embodiment of an ICA system generally directed to obtaining and using panorama images from within one or more buildings or other structures); each of which is incorporated herein by reference in its entirety.

In the example of FIG. 1A, the FMGM system may perform automated operations involved in using images acquired at multiple associated viewing locations (e.g., in multiple rooms or other locations within a building or other structure and optionally around some or all of the exterior of the building or other structure) to generate a 2D floor map for the building or other structure and/or to otherwise generate a computer model for the building or other structure (e.g., a 3D model and/or a 2.5D model), such as by analyzing visual information available in the images, and for providing a representation of an interior of the building or other structure (e.g., for subsequent use in controlling the simultaneous and coordinated presentation of multiple types of information about the interior of the building or other structure). For example, in at least some such embodiments, such techniques may include analyzing one or more images taken in a room to determine a shape of the room and/or to identify inter-room passages (e.g., doorways and other openings in walls) into and/or out of the room. After the shapes of some or all of the rooms are determined, the techniques may further include positioning the room shapes relative to each other to form a 2D floor map (e.g., based at least in part on connecting inter-room passages between rooms, and optionally using travel or other movement information captured between the viewing locations to determine relative locations of the viewing locations with respect to each other), optionally combined with height and/or other size information to generate a 3D and/or 2.5D model of the building or other structure, and then providing the generated computer model(s) and optionally 2D floor map for subsequent use by the BHP system. Additional details related to embodiments of a system providing at least some such functionality of an FMGM system are included in U.S. Non-Provisional patent application Ser. No. 16/190,162, filed Nov. 14, 2018 and entitled "Automated Mapping Information Generation From Inter-Connected Images"; and in U.S. Provisional Patent Application No. 62/893,108, filed Aug. 28, 2019 and entitled "Automated Tools For Generating Mapping Information For Buildings" (which includes disclosure of an MIGM system that is one example embodiment of a FMGM system generally directed to generating floor maps and other computer models for one or more buildings or other structures based in part of input from one or more system operator users); each of which is incorporated herein by reference in its entirety.

One or more end users (not shown) of one or more building information viewer client computing devices **175** may each further interact over computer networks **170** with the BHP system **140** (and optionally the ICA system **160** and/or FMGM system **160**), such as to obtain, display and interact with a generated 3D computer model and/or other model (e.g., a 2D floor map) that are part of multiple types of information about the house or other building being presented in a GUI displayed on a device **175** (e.g., based at least in part on user-specified conditions), such as in a simultaneous and coordinated manner. In addition, while not illustrated in FIG. 1A, a 3D computer model (or portion of it) and/or other model (e.g., 2D floor map) may be linked to

or otherwise associated with one or more additional types of information, such as one or more associated and linked images or other associated and linked information, including for a two-dimensional (“2D”) floor map of a building to be inter-linked with or otherwise associated with a separate 2.5D model rendering of the building and/or a 3D floor plan model rendering of the building, etc., and including for a computer model and/or floor map of a multi-story or otherwise multi-level building to have multiple associated sub-floor models or maps for different stories or levels that are interlinked (e.g., via connecting stairway passages). Accordingly, non-exclusive examples of an end user’s interactions with a displayed or otherwise generated computer model (e.g., a 2.5D or 3D model view that optionally includes images texture-mapped to walls of the displayed model) and/or 2D floor map of a building may include one or more of the following: to change between a computer model view and a floor map view (collectively referred to herein as one or more mapping views); to change between a mapping view and a view of a particular image at a viewing location within or near the building’s interior; to change the horizontal and/or vertical viewing direction from which a corresponding subset view of (or portal into) a panorama image is displayed, such as to determine a portion of a panorama image in a 3D spherical coordinate system to which a current user viewing direction is directed, and to render a corresponding planar image that illustrates that portion of the panorama image without the curvature or other distortions present in the original panorama image; etc. Additional details regarding embodiments of a system providing at least some such functionality of a BHP system (such as to provide or otherwise support at least some functionality to an end user using a building information viewer system and routine as discussed herein) are included in U.S. Non-Provisional patent application Ser. No. 15/950,881, filed Apr. 11, 2018 and entitled “Presenting Image Transition Sequences Between Viewing Locations” (which includes disclosure of an ILTM system that is one example embodiment of a BHP system generally directed to generating and displaying transitions between images captured at different viewing locations); and in U.S. Provisional Patent Application No. 62/911,959, filed Oct. 7, 2019 and entitled “Providing Simulated Lighting Information For Three-Dimensional Building Models” (which includes disclosure of a BMLSM system that is one example embodiment of a BHP system generally directed to generating and displaying simulated lighting information in a three-dimensional model of a building’s interior); each of which is incorporated herein by reference in its entirety. For example, a computer model of an interior of a house or other building may be a 3D (three-dimensional) or 2.5D (two and a half dimensional) representation that is generated after the house is built and that shows physical components of the house’s actual interior (e.g., walls, windows, doors, stairs, fireplaces, kitchen islands, cabinets, counters, lighting and/or plumbing fixtures and associated built-in elements such as sinks and showers/baths, curtains, wallpaper or paint, floor coverings, etc.), such as from analysis of images acquired in the house’s interior to reflect a current structure of the house (and optionally non-fixed or temporary elements in the house, such as furniture and/or furnishings). In some embodiments, automated operations may be performed that are involved in using images acquired at multiple associated viewing locations (e.g., in multiple rooms or other locations within a building or other structure and optionally around some or all of the exterior of the building or other structure) to generate a 2D floor map for the building or other structure and/or to

generate a computer model for the building or other structure (e.g., a 3D model and/or a 2.5D model), such as by analyzing visual information available in the images, and for providing a representation of an interior of the building or other structure (e.g., for subsequent use in generating and presenting conditions for the interior of the building or other structure)—for example, in at least some such embodiments, such techniques may include analyzing one or more images taken in a room to determine a shape of the room and/or to identify inter-room passages (e.g., doorways and other openings in walls) into and/or out of the room. In at least some embodiments, an automated analysis of some or all images may further be performed to determine corresponding information about the building interior, such as types of rooms, points of interest in particular locations, etc. In addition, a model of a building interior may be displayed in at least some embodiments to a user in a displayed GUI on a client computing device, and the user may be able to specify via the GUI (or in another manner) at least some of the conditions for how the display is generated, such as one or more of the following: one or more target times; an amount of the house or other building interior to display (e.g., one or more specific rooms, the entire interior, etc.); effects of changes to the building interior (e.g., adding or removing a window; adding or removing part or all of a wall; changing furnishings or moveable elements; changing the color and/or texture of a surface, such as a wall or a floor or a ceiling or a countertop; adding or removing lighting sources at specified locations; etc.); effects of changes outside the building interior (e.g., adding or removing or changing a tree or other vegetation in an environment surrounding the building, such as in a yard of a house; adding or removing or changing an exterior building or other external structure, whether on a same property as the building or a nearby property; etc.); a speed or rate at which an animation is displayed or other displayed information is changed; etc. In some embodiments, one or more types of additional information may be associated with and optionally displayed with a computer 3D model (e.g., with full height information represented) or computer 2.5D model (e.g., with partial representations of height shown) of a building’s interior. As one example, one or more types of additional information about a building may be received, associated and displayed with such a model (e.g., with particular locations in particular rooms) or otherwise accessible from the displayed model (e.g., upon selection by a user), such as one or more of the following: images; textual and/or audio annotations or other descriptions of particular rooms or other locations; other audio information, such as recordings of ambient noise; estimated room width, length and/or height dimensions; external information from an environment surrounding the building, such as about nearby buildings and/or vegetation (e.g., as identified from satellite or other external images of the building, such as taken from the building and/or from a nearby street or yard; as identified from data in one or more external databases or other information sources, such as street maps or other government records; etc.), whether by displaying the actual images or by generating and displaying visual representations of particular external elements that are identified and modeled from images or other external information sources; in-room images for a room that are projected on the walls of the room shown in the model; geographical location and/or orientation information for the building; user-generated and/or ‘crowd-sourced’ information provided by one or more end users about the building, such as interior and/or exterior images, descriptions, etc.; a 2D (two-dimensional) floor map of the building interior, such as

using an overhead schematic view (e.g., an orthographic top view); etc. A floor map for a house may, for example, be presented to an end user in a GUI, such as with room labels added to some or all rooms (e.g., “living room”), room dimensions for some or all rooms, visual indications of fixtures or appliances or other built-in features for some or all rooms (e.g., for the bathroom), visual indications of positions of additional types of associated and linked information may be added (e.g., of panorama images and/or perspective images that an end user may select for further display, of audio annotations and/or sound recordings that an end user may select for further presentation, etc., as shown in the living room and master bedroom and kitchen/dining room), visual indications of doors and windows may be shown, etc. In addition, a user-selectable control **228** may be used to indicate a current floor that is displayed for the floor map, and to allow the end user to select a different floor to be displayed—in some embodiments, a change in floors or other levels may also be made directly from the floor map, such as via selection of a connecting passage, such as the stairs to floor 2 in the illustrated floor map. In addition, while not illustrated in FIG. 1A, in some embodiments the client computing devices **175** (or other devices, not shown) may receive and use generated computer models and/or other generated mapping-related information in additional manners, such as to control or assist automated navigation activities by those devices (e.g., by autonomous vehicles or other devices), whether instead of or in addition to display of the generated information.

In the depicted computing environment of FIG. 1A, the network **170** may be one or more publicly accessible linked networks, possibly operated by various distinct parties, such as the Internet. In other implementations, the network **170** may have other forms, such as to instead be a private network (such as a corporate or university network) that is wholly or partially inaccessible to non-privileged users. In still other implementations, the network **170** may include both private and public networks, with one or more of the private networks having access to and/or from one or more of the public networks. Furthermore, the network **170** may include various types of wired and/or wireless networks and connections in various situations.

FIG. 1B depicts a block diagram of an exemplary building interior environment in which images are acquired and for which one or more computer models and/or 2D floor maps are generated, such as for further use by the BHP system to control the simultaneous and coordinated presentation of multiple types of information about the interior of the house, as discussed in greater detail with respect to FIGS. 2A-2U, as well as for use in some embodiments in otherwise presenting the computer models and/or floor maps and/or images to users. In particular, FIG. 1B illustrates a first story of a multi-story building **198** (e.g., with a partial or full basement and/or a second story, not shown) with an interior that was captured at least in part via multiple panorama images, such as by a mobile image acquisition device **185** with image acquisition capabilities as it is moved through the building interior to a sequence of multiple viewing locations **210** (e.g., starting at viewing location **210A**, moving to viewing location **210B** along travel path **115**, etc.). An embodiment of the ICA system (e.g., ICA system **160** on server computing system(s) **180**, a copy **155** of some or all of the ICA system executing on the mobile image acquisition device **185**, etc.) may automatically perform or assist in the capturing of the data representing the building interior, as well as to further analyze the captured data to generate panorama images to provide a visual representation of the

building interior, and an embodiment of the FMGM system (e.g., FMGM system **160** on server computing system(s) **180**, a copy **157** of some or all of the FMGM system executing on the mobile image acquisition device **185**, etc.) may automatically perform or assist in the generation of one or more computer models and/or a 2D floor map representing the building interior. While such a mobile image acquisition device may include various hardware components, such as a camera, one or more sensors (e.g., a gyroscope, an accelerometer, a compass, etc., such as part of one or more IMUs, or inertial measurement units, of the mobile device; an altimeter; light detector; etc.), a GPS receiver, one or more hardware processors, memory, a display, a microphone, etc., the mobile device may not in at least some embodiments have access to or use equipment to measure the depth of objects in the building relative to a location of the mobile device, such that relationships between different panorama images and their viewing locations may be determined in part or in whole based on features in different images, but without using any data from any such depth sensors, while in other embodiments one or more such depth sensors or other distance-sensing devices may provide depth data that is used in combination with other information from analysis of visual data of captured images. In addition, while geographical orientation/directional indicator **109** is provided in FIG. 1B for reference of the viewer, the mobile device and/or ICA system and/or FMGM system may not use such absolute directional information in at least some embodiments, such as to instead determine relative directions and distances between viewing locations **210** without regard to actual geographical positions or directions in such embodiments.

In operation, the mobile image acquisition device **185** arrives at a first viewing location **210A** within a first room of the building interior (in this example, in a living room accessible via an external door **190-1**), and captures a view of a portion of the building interior that is visible from that viewing location **210A** (e.g., some or all of the first room, and optionally small portions of one or more other adjacent or nearby rooms, such as through doors, halls, stairs or other connecting passages from the first room). The view capture may be performed in various manners as discussed herein, and may capture information about a number of objects or other features (e.g., structural details) that are visible in images captured from the viewing location—in the example of FIG. 1B, such objects or other features throughout the house include the doorways **190** (including **190-1** and **190-3**) and **197** (e.g., with swinging and/or sliding doors), windows **196** (including **196-1**, **196-2**, **196-3** and **196-4**), corners or edges **195** (including corner **195-1** in the northwest corner of the building **198**, corner **195-2** in the northeast corner of the first room, corner **195-3** in the southwest corner of the first room, corner **195-4** at the northern edge of the inter-room passage between the first room and a hallway, etc.), furniture **191-193** (e.g., a couch **191**; chair **192**; table **193**; etc.), pictures or paintings or televisions or other hanging objects **194** (such as **194-1** and **194-2**) hung on walls, light fixtures, various built-in appliances or fixtures (not shown), other types of building information, etc. The user may also optionally provide a textual or auditory identifier to be associated with a viewing location, such as “living room” for the room including viewing locations **210A** and/or **210B** and/or identifiers “entry” and “living room—NE” for the viewing locations **210A** and **210B**, respectively, while in other embodiments the ICA system and/or FMGM may automatically generate some or all such identifiers (e.g., by automatically analyzing video and/or

other recorded information for a building to perform a corresponding automated determination, such as by using machine learning) or the BHP system may determine such identifiers (e.g., based at least in part on input from BHP system operator users and/or end users) or the identifiers may not be used.

After the first viewing location **210A** has been adequately captured, the mobile device **185** may move or be moved to a next viewing location (such as viewing location **210B**), optionally recording movement data such as video and/or other data from the hardware components (e.g., from one or more IMUs, from the camera, etc.) during movement between the viewing locations. At the next viewing location, the mobile device may similarly capture a panorama image from that viewing location. This process may repeat for some or all rooms of the building and optionally external to the building, as illustrated for viewing locations **210C-210J** in this example. The acquired panorama images for each viewing location may be further analyzed, including in some embodiments to render or otherwise place each panorama image in an equirectangular format, whether at the time of image capture or later.

Various details are provided with respect to FIGS. **1A-1B**, but it will be appreciated that the provided details are non-exclusive examples included for illustrative purposes, and other embodiments may be performed in other manners without some or all such details.

FIGS. **2A-2U** illustrate examples of presenting a GUI that simultaneously displays multiple types of information about an interior of a building in an integrated and coordinated manner, such as for the building **198** and using images and their viewing/capture locations **210** discussed in FIG. **1B**.

In particular, FIG. **2A** illustrates an example embodiment of a GUI with various information **204a**, which is displayed in this example on a mobile client device **205** (e.g., a smart phone or tablet), and which shows multiple types of information about a common area of example building **198**. The GUI in this example includes a primary pane **207** and two secondary panes **208** and **209**, with each of the panes showing information of a different type about the same area of the example house **198** shown in FIG. **1B**. The primary pane **207** is showing an image taken from viewing location **210A** in the living room in this example, with the direction of the image being in the northeast direction (as shown by visual indicator **109a** overlaid on the primary pane, as well as the visual indicator **219a** shown in secondary pane **209**). In this example, the primary pane **207** also includes a header **206** that provides a description of the type of content shown (here, an image, as illustrated by the “photo gallery” label), as well as optionally having an additional label specific to the photo or other image being displayed (here, “Living Room #1”).

The primary pane **207** may also have one or more user-selectable controls that enable the end user (not shown) to modify information being displayed in the GUI, such as control **218a** in the header area **206** to change the type of information being shown in the primary pane to a different type of content (e.g., by cycling through each of the available types of content). In addition, other possible user-selectable controls **201** are overlaid on the primary pane, such as a toggle control **203c** to show or hide information about points of interest that are present in the current image (e.g., types of building information determined in part or in whole from automated analysis of visual data of captured images), a toggle control **203d** to show or hide a description of the area of the house shown by the image, a toggle control **203e** to show or hide information about questions and

answers corresponding to the area of the house shown in the image and to optionally allow the end user to supply one or more additional questions or answers, a toggle control **203b** to switch to a so-called “AR” (or augmented reality) mode in which tilting and rotating the body of the mobile device causes the displayed image to move accordingly (e.g., if the image shown in the primary pane is a 360° panorama image with only a subset of it currently shown, such that tilting to the left causes an additional portion of the panorama image to the left of the visible area to be shown, and with the control **203b** not being shown if the content is not a panorama image), a selection control **203a** to switch to another image in the photo gallery (e.g., to cycle through all available images), etc.—as discussed in greater detail elsewhere herein, in at least some embodiments and situations, some or all of the displayed user-selectable controls may be contextual based on a type of content currently shown in the primary pane (in this example, associated with image content).

In addition to the image shown in the primary pane of the northeast corner of the living room of the example house, the secondary panes **208** and **209** show other types of content about the same location or area of the example house. In particular, the secondary pane **209** in this example shows a portion of a 3D computer model of the house, and in particular shows a portion of the computer model that includes the northeast corner of the living room, as well as optionally including some or all of other parts of the same floor—as previously noted, the computer model is overlaid in this example with the visual indicator **219a** to illustrate where the image shown in the primary pane was captured, and the orientation of the camera that captured the image. In addition, the secondary pane **208** in this example shows a portion of an interface to an interactive virtual tour of the house, with the interactive tour having a plurality of interconnected viewing/capture locations at which images and/or other information that are available for viewing or other presentation were captured. In this example, the interface includes an image that was also captured from viewing location **210A** (e.g., a panorama image captured from that viewing location), with the interface further including visual indicators **214b** and **214c** that each correspond to other viewing locations different from viewing location **210A** (in particular, to viewing locations **210B** and **210C** of FIG. **1B**, respectively)—as discussed in greater detail with respect to FIG. **2C**, such visual indicators **214** may be user-selectable controls in at least some situations (e.g., when the interface to the interactive tour is shown in the primary pane) such that selection of one of the controls changes the image displayed to change to one from the viewing location associated with the selected control.

It will be appreciated that a variety of types of user interactions may occur with example embodiments of the GUI, such as to enable an end user (not shown) to select a secondary pane and cause its content to be moved to the primary pane, with new contents of that secondary pane being selected to correspond to the new primary pane contents (e.g., to move the contents that were in the primary pane to that secondary pane, to select a new content type to display in the secondary pane, etc.). Other optional user-selectable controls **202** are further shown in this example for reference purposes, although they may not be visible in some embodiments when three GUI panes are displayed as shown, such as if the controls **202** are associated with a different part of the GUI as discussed in greater detail with respect to FIG. **2F**.

FIG. 2B continues the example of FIG. 2A, and in particular corresponds to the end user having selected the control **203a** in FIG. 2A to change the image that is displayed in the primary pane to another image from the photo gallery. In this example, the new image displayed in the primary pane **207** as part of the updated information **204b** in the updated GUI is also taken from the same viewing location **210A**, but in a northwesterly direction (as illustrated by the updated visual indicator **219b** shown in the 3D computer model of the secondary pane **209**). In this example, the contents of the secondary pane **209** continue to be the same portion of the 3D computer model as in FIG. 2A (with the updated visual indicator **219b**), which continues to correspond to the area of the house shown in the primary pane of FIG. 2B, and the contents of the secondary pane **208** continue to be the same portion of the interactive tour interface that correspond to the content of FIG. 2B as well (e.g., since the image in FIG. 2B continues to be taken from the same viewing/capture location as in FIG. 2A). It will be appreciated that the header portion **206** of the primary pane **207** is also updated in FIG. 2B to reflect the new image being shown in the primary pane, although in some embodiments such image-specific labels may not be used. It is also noted that the user-selectable controls **202** mentioned in FIG. 2A are not shown in FIG. 2B.

In addition, FIG. 2B further illustrates additional information that has been overlaid on the primary pane **207**, based on selection by the end user of the user-selectable controls **203c**, **203d** and **203e** in this example, although it will be appreciated that the end user may instead select only zero, one, or two of those three controls in other situations. In this example, selection of the user-selectable control **203c** has caused several visual indicators **212** for points of interest in the room to be illustrated, with visual indicator **212b** being currently selected and having a corresponding textual comment in the area **213** of the primary pane (to comment about paint on the walls of the room). Other visual POI indicators in this example include **212a** on the west-facing picture window, **212d** on the north-facing window, and **212c** on the overhead track lighting on the ceiling. While the selected visual indicator **212b** has associated text that is displayed in this example, other visual indicators for POIs may have other types of information associated, such as if the window visual indicators **212a** and/or **212d** have images and/or video associated with them, such as to show images or videos looking out the window (e.g., a time-lapse video over a 24-hour period of the exterior of the house from a window or door, such as to show road traffic or people traffic outside over that time period). FIG. 2P provides additional details about an example of automated analysis of visual data in an image captured in the building to identify types of building information to use for such POIs and/or to determine information to be displayed for such POIs, with additional details about such analysis included elsewhere herein. In addition to the activation of the control **203c**, the user-selectable control **203d** has also been activated to provide an audio description of the area shown in the image, with the visual information **211** shown in this example representing audio information that may be audibly presented in response to the selection of that control (e.g., instead of having a textual representation of the information as shown in this example, or instead in addition to the textual information, such as if a closed captioning option is selected). Furthermore, the user-selectable control **203b** corresponding to questions and answers is also selected, causing additional information in the area **213** to be shown, such as a question from another end user and a correspond-

ing answer from a real estate listing agent for the house, as well as further user-selectable controls to allow the end user to ask a question to be answered, submit a comment for display to others, or to cycle through other existing questions and comments. It will be appreciated that illustrated types of information may be presented in other manners in other embodiments, or may not be shown.

FIG. 2C continues the examples of FIGS. 2A-2B, and illustrates an example of the end user interacting with the GUI displayed in FIG. 2A to initiate a switch of the content between the primary pane **207** and the secondary pane **208**, such that the primary pane **207** in the updated information **204c** of the updated GUI of FIG. 2C is the interface to the interactive tour of the house, with the visual indicators **214b** and **214c** in FIG. 2C now being selectable by the user to change the current viewing location, as further illustrated with respect to FIG. 2D. In at least some embodiments and situations, the information displayed in the secondary pane **209** would not change in FIG. 2C (other than updating the visual indicator **219c**), such as due to the content of the primary pane continuing to correspond to the same portion of the 3D computer model that was shown in FIGS. 2A and 2B—in this example, however, the information in the secondary pane **209** has been updated for the purposes of illustration to show the entire 3D computer model for the current floor of the house. In addition, contents of the secondary pane **208** have been updated in this example to show the image that was previously present in the primary pane in FIG. 2A. It will be appreciated that the header portion **206** of the primary pane **207** is also updated in FIG. 2C to reflect the new type of content being shown in the primary pane.

FIG. 2D continues the examples of FIGS. 2A-2C, and in this example corresponds to the end user having selected the user-selectable visual indicator **214b** in FIG. 2C to change the current viewing location for the interactive tour. In response to that selection, the background image used for the interactive tour interface in the primary pane **207** of FIG. 2D has changed to the updated information **204d** shown in the primary pane for the updated GUI, corresponding to an image taken from the viewing location **210B** in the northeast part of the living room, and the user-selectable visual indicators in the primary pane have similarly been updated, with the direction of the previous indicator **214c** changing to point to the direction of the hallway from the new background image that is shown, and with the previous visual indicator **214b** for the northeast living room viewing location **210B** (which is now the current viewing location) being changed to the new user-selectable visual indicator **214a** for the entry viewing location **210A** in the living room (which was the previous viewing location). In addition, a new visual indicator **203f** has been added to reflect an alternative manner for the end user to adjust the panorama image shown as the background of the primary pane, such as to manually drag the image up, down, left and/or right to display other parts of the panorama image that are not currently visible in the subset shown in the primary pane, as discussed further in FIG. 2E. As in the previous examples, the visual indicator **219d** in the 3D computer model of the secondary pane **209** has been updated to correspond to the location and orientation at which the new background image shown in the primary pane was captured. In addition, while the content previously shown in the secondary pane **208** of FIG. 2C may in some embodiments and situations continue to be shown in the secondary pane **208** in FIG. 2D, in this example the content has been changed for illustrative purposes to provide content of another type that corresponds to the same area of

the house, which in this example is a video of at least that portion of the house. In this example, the video in the secondary pane **208** includes a visual indicator **203g** of a play button for the video, although the visual indicator may not be user-selectable in at least some embodiments until the video content is moved to the primary pane.

FIG. **2E** continues the examples of FIG. **2A-2D**, and in this example illustrates the effects of the end user having used the control **203f** of FIG. **2D** to change the subset of the background panorama image (e.g., a 360° panorama image) that is shown by rotating approximately 180°, so as to now point toward the southwest corner of the living room from the viewing location **210B** in the northeast corner of the living room, as shown in the updated information **204e** of the updated GUI. In this example, the user-selectable visual indicators **214c** and **214a** (for viewing locations **210C** and **210A**, respectively) have been updated to correspond to the positions of those viewing locations relative to the content shown in the background image, and the visual indicator **219e** in the 3D computer model of the secondary pane **209** has been similarly updated. While the contents of the secondary pane **208** may be unchanged in this situation, the image in the photo gallery of secondary pane **208** has been changed in this example to an image that is closest to that of the current background image in the primary pane (so as to maintain a coordinated display of information that is integrated with the primary pane), which in this example is of the window of the west wall of the living room. In addition, this example further illustrates that additional types of information may be overlaid on images in at least some situations, such as in this example to overlay simulated lighting information **216a** on that image (although a corresponding user-selectable control to initiate that display is not shown in this example). It will be appreciated that additional overlay information, such as that of the simulated lighting, may be controlled by the end user in various manners, including as is discussed in greater detail with respect to FIG. **2F**.

FIG. **2F** continues the examples of FIGS. **2A-2E**, and illustrates updated information **204f** in the updated GUI in which the secondary panes **208** and **209** are not shown, but additional user-selectable controls **202** are included (e.g., based on the primary pane **207** being changed to show the 3D computer model of the house). In this example, the header information **206** is updated to include an additional user-selectable control **218b** that allows the end user to select which floor of the house is shown, with the house in this example having an additional basement floor accessible via the stairs (as illustrated further with respect to FIG. **2G**). In this example, the 3D computer model includes illustrations of the positions of the viewing/capture locations for the interactive tour, with the visual indicator **216a** being added to correspond to the current viewing location that was last selected. This example further includes a user-selectable control **216b** that allows an end user to orient the computer model of the house in different manners according to different specified criteria, such as to have a top of the primary pane correspond to magnetic or geographic north, have the top or bottom of the primary pane correspond to the main entry of the house, to provide a best fit of the 3D computer model to the current size and shape of the primary pane, etc. In addition, the user-selectable controls **202** may enable various types of additional information to be overlaid on the floor map or to otherwise invoke additional functionality to be provided, such as one or more of the following: control **202a** activates a default mode that allows the end user to move to a detailed view of a particular room or viewing

location by selecting that room or viewing location on the 3D computer model; control **202b** shows additional descriptive information of one or more types on the computer model, such as one or more types of POIs to show one or more types of building information (e.g., as selected by the user, based on available types of building information, etc.); control **202c** shows measurements or other scale information on the 3D computer model; control **202d** shows simulated sunlight on the 3D computer model for specified conditions (e.g., one or more times of day and/or times of year); control **202e** shows actual interior lighting, optionally under specified conditions; control **202f** shows information about a surrounding environment of the building (with FIG. **2G** providing one example); control **202g** provides sound recordings from one or more locations of the building (e.g., of ambient sound at specified times); control **202z** allows virtual objects to be added to the 3D computer model and/or surfaces in the 3D computer model to have virtual changes (e.g., to change color, texture etc. of walls, floors, object surfaces, etc.); etc.—it will be appreciated that various other types of controls **202** may be provided in other embodiments, and/or that some of the illustrated types of controls **202** may not be used.

FIG. **2G** continues the examples of FIGS. **2A-2F**, and illustrates an example of the GUI being updated with information **204g** to again include only a single primary pane **207**, which in this example has no header or separate area for user-selectable controls—in addition, the information being displayed has been adjusted to reflect that the device **205** has been rotated to a landscape orientation. In this example, the end user has selected to display information about the surroundings of the building, which in this example includes a street to the west of the house, with two additional houses across the street being shown, as well as additional information on the house's property that includes two trees, sidewalks, a driveway and garage, and bushes or other shrubs on the south side of the house (as indicated by the visual indicator **109g**). This example further illustrates a deck to the east of the house, and includes visual information about a basement existing below ground level, although details of the interior of the basement are not shown in this example. The vegetation and surrounding buildings are shown in this example using simplified geometrical shapes, such as to enable the use of such shapes to simulate shading (not shown) if a simulated lighting information option is selected for the display, although actual images of surroundings may instead be used in other embodiments and situations. It will be appreciated that a variety of other types of information may be shown about the surroundings of the building, including images and/or video from ground level and/or an aerial view, as well as additional points of interest in descriptive information about the surrounding neighborhood.

FIG. **2H** continues the examples of FIGS. **2A-2G**, and illustrates an example of the GUI similar to that of FIG. **2F**, but updated with information **204h** corresponding to selection of control **202h** by the end user. In this example, the control **202h** corresponds to updating the displayed floor plan of the house to visually show information about spaces of the house that are public (e.g., living room, kitchen, dining room, hallways, stairs, etc.) and that are private (e.g., bathrooms, bedrooms, etc.), such as displaying one or both types of spaces with specified colors and/or patterns. In this example, a legend **221h** is displayed to show options **222h** for patterns to use, with the displayed floor plan having corresponding displayed information (e.g., via a public/private visual layer that is overlaid on the floor plan). The

public and private spaces of the house may be determined in various manners in various embodiments, such as automatically (e.g., based on previously determined room types, based on analysis of images) and/or based on user annotations or other input (e.g., from one or more system operator users of the BHP and/or ICA systems, from end users, etc.).

FIG. 2I continues the examples of FIGS. 2A-2H, and illustrates an example of the GUI similar to that of FIG. 2H, but instead being updated with information **204i** (instead of information **204h**) corresponding to selection of control **202i** by the end user. In this example, the control **202i** corresponds to updating the displayed floor plan of the house to visually show icon information about types of rooms of the house and/or associated types of room functionality (e.g., instead of the room type textual labels shown in FIG. 2H). In this example, a legend **221i** is displayed to show icons **222i** to use for different types of rooms, with the displayed floor plan having corresponding displayed icons (e.g., via a room type icon visual layer that is overlaid on the floor plan, such as instead of or in addition to a room type textual label visual layer). As previously discussed, types of rooms may be determined in various manners in various embodiments, such as automatically (e.g., based on analysis of images and/or use of machine learning techniques) and/or based on user annotations or other input (e.g., from one or more system operator users of the BHP and/or ICA systems, from end users, etc.).

FIG. 2J continues the examples of FIGS. 2A-2I, and illustrates an example of the GUI similar to that of FIG. 2I, but being updated with information **204j** corresponding to selection of control **202j** by the end user. In this example, the control **202j** corresponds to updating the displayed floor plan of the house to visually show examples of inhabitant flow pattern information **221j** corresponding to typical or common movement patterns of people (e.g., in addition to room type icons, while in other embodiments may be shown without room type label or icon information). In this example, the flow pattern information may be displayed, for example, via a flow pattern visual layer that is overlaid on the floor plan, such as instead of or in addition to one or more other visual layers. Such flow pattern information may be determined in various manners in various embodiments, such as automatically (e.g., based on analysis of video taken over time within the house interior, based on other tracking of user movements within the house interior, based on analysis of images to determine open lanes or spaces for user movement, etc.) and/or based on user annotations or other input (e.g., from one or more system operator users of the BHP and/or ICA systems, from end users, etc.).

FIG. 2K continues the examples of FIGS. 2A-2J, and illustrates an example of the GUI similar to that of FIG. 2H, but updated with information **204k** corresponding to selection of control **202k** by the end user. In this example, the control **202k** corresponds to updating the displayed floor plan of the house to visually show information about spaces of the house that are likely to be of most interest to the end user, such as displaying spaces corresponding to different levels of likely user interest with different specified colors and/or patterns. In this example, a legend **221k** is displayed to show patterns **222k** for patterns to use, with the displayed floor plan having corresponding displayed information (e.g., via a user-specific personalized visual layer that is overlaid on the floor plan). The areas of the house that are likely to be of interest to the end user may be determined in various manners in various embodiments, such as automatically (e.g., based on tracking a quantity of time and/or a length of time that the end user has previously spent viewing different

parts of this house, based on an analysis of corresponding types of information for the end user from multiple other houses, etc.) and/or based on user annotations or other input (e.g., from previously specified preferences of the end user; from previous indications of the end user of particular parts of the house that are of interest, such as by flagging or pinning particular rooms and/or images; etc.).

FIG. 2L continues the examples of FIGS. 2A-2K, and illustrates an example of the GUI similar to that of FIG. 2F, but updated with information **204l** corresponding to selection of control **202l** by the end user. In this example, the control **202l** corresponds to providing interactive functionality for the end user to specify a length on the displayed floor plan of the house (e.g., by dragging a line **223l**, by selecting two end points, etc.) and receive information about the distance of that length (e.g., displayed distance information **224l**). The distance may be automatically determined in various manners in various embodiments, such as based on previous and/or concurrent analysis of images of the house interior to determine sizes of known or unknown objects, as discussed in greater detail elsewhere herein. In addition, while the distance functionality is provided using a 3D floor plan in this example, similar functionality may be provided on other media or types of information in other embodiments, such as on displayed panorama or perspective images, during interactive virtual tours of inter-linked viewing locations, etc.

FIG. 2M continues the examples of FIGS. 2A-2L, and illustrates an example of the GUI updated with information corresponding to selection of control **202m** by the end user. In this example, the control **202m** includes a time-based slider (and associated information) **226m** that controls what types of information are displayed in the one or more panes, which in this example includes user-selectable indicators **223m** corresponding to viewing/capture locations at which images and/or other data is captured in the building, and such as based on the acquisition times for those images and/or other data. In comparison to the viewing/capture locations illustrated in FIG. 2L, the viewing/capture locations include two acquisition locations **223m** (in this example, to corresponding to viewing/capture locations outside of the house, which are captured at a later time after the images and/or other data captured at the viewing/capture locations inside the house), and the user-selected time corresponds to a current time (such as to shown all acquisition locations for the building).

FIG. 2N continues the examples of FIGS. 2A-2M, and illustrates an example of the GUI that is further updated with information corresponding to modification of the time-based slider control and associated information change **226n** by the user, as shown in updated information **202n**. In this example, the time has been changed to an earlier date, and one of the viewing/capture locations **223m** that was shown in FIG. 2M is no longer displayed (as shown with indicator **223n**) due to being acquired after the currently selected time.

FIG. 2O (also referred to as “2-0” herein to differentiate from the number **20**) continues the examples of FIGS. 2A-2N, and illustrates an example of the GUI in which the 3D computer model shown in FIG. 2N has been updated to a 2D floor map model of the same floor (the currently selected main floor, or “Floor 1”), and is further updated with information corresponding to further modification of the time-based slider control and associated information **226o** by the user, as shown in updated information **202o**. In this example, the time has been changed to an earlier date before such remodeling of the house had been completed and before some of the previously displayed viewing/cap-

ture locations were used to acquire images or other data. In this example, visual indicators **223o** indicate the absence of viewing/capture locations that were shown at the later time corresponding to FIG. 2N, and additional structural areas **227o** and **228o** are shown that were removed by the later time corresponding to FIG. 2N. It will be appreciated that other times of information may similarly be determined for a house or other building at different times (e.g., with different corresponding computer models and associated additional information), with the display of such building information changing based on a currently selected time. As discussed elsewhere herein, various types of changes over time may be illustrated in other manners, including with animation or other changes played over a period of time, including with respect to the types of information discussed in FIG. 2-O and elsewhere herein.

FIG. 2P continues the examples of FIGS. 2A-2O, and illustrates an example of an image **250p** that is acquired in the living room of the house, with various types of building information **199** that may be automatically determined via analysis of visual data of the image, such as for use in POIs displayed in the GUI (e.g., POIs similar to those discussed with respect to FIG. 2B). In this example, the types of building information may include an outlet **199a** for one or more types of wiring (in this example, a combined electrical and cable outlet), wall surface **199b** (e.g., type of material, such as wallpaper or paint; color; texture; etc.), window type and/or associated furnishings **199c** for window **196-2** (e.g., a picture window, a window that opens by swinging inwards, window curtains or drapes, etc.), other furnishings **199d** (e.g., a tapestry on a wall), furniture **199e** (e.g., built-in furniture, such as a window seat; moveable furniture; etc.), lighting fixture type **199f**, piping or other conduit information **199g** (e.g., to correspond to an HVAC air vent), etc. It will be appreciated that various other types of building information may be determined in other situations, including for other types of rooms such as bathrooms (e.g., sinks/bathtubs/showers and associated types of plumbing fixtures, floor type, counter type, types of lighting fixtures, etc.), kitchens (e.g., sinks and associated types of plumbing fixtures, floor type, counter type, cabinet types, types of lighting fixtures, kitchen islands and/or other build-ins, appliances, etc.), utility rooms (e.g., sinks and associated types of plumbing fixtures, floor type, counter type, types of lighting fixtures, appliances, etc.), etc., as discussed in greater detail elsewhere herein.

FIG. 2Q continues the examples of FIGS. 2A-2P, and illustrates an example of the GUI updated with information corresponding to selection of control **202q** by the end user. In this example, the control **202q** is a slider that controls what types of information about infrastructure are overlaid on information displayed in the one or more panes, such as with respect to wiring on one or more types, piping or other conduits, etc., and such as may be further specified using a user-selectable 'settings' control **226q** and/or based on previously selected or otherwise specified information (e.g., user preferences)—in other embodiments, one or more toggle controls may instead be used to turn on or off the display of information about one or more types of infrastructure (or other types of building information displayed as POIs). In this example, the use of the control causes types of building information discussed with respect to FIG. 2P to be displayed, including a visual indicator **233q** corresponding to an air vent and a visual indicator **232q** corresponding to an electrical outlet. It will be appreciated that the selected type(s) of infrastructure may be displayed throughout the portions of the house currently shown in the GUI based on

analysis of visual data of corresponding images, including to be overlaid on other types of underlying information (e.g., on images, interactive tours, 3D computer models, 2D floor map models, etc.), and in some cases may be displayed with a user-selectable visual indicator to enable a particular POI to be selected to cause additional information to be displayed (e.g., one or more images from which the information for the POI was determined, additional types of information about the type of infrastructure corresponding to a selected POI, etc.).

FIG. 2R continues the examples of FIGS. 2A-2Q, and illustrates an example of the GUI updated with information corresponding to selection of control **202r** by the end user. In this example, the control **202r** is a slider that controls virtual removal of information that would otherwise be present in the information for the building displayed in the one or more panes, such as with respect to one or more of walls or other structural elements, furnishings, furniture, fixtures, etc., and such as may be further specified using a user-selectable 'settings' control **226r** and/or based on previously selected or otherwise specified information (e.g., user preferences)—in other embodiments, one or more toggle controls may instead be used to turn on or off the virtual removal of one or more types of information. In this example, the use of the control causes building information to be virtually removed that includes the pantry **229r** (e.g., as part of a consideration to remodel the kitchen and to use that space for another purpose), bathroom fixtures **227r**, etc. It will be appreciated that the virtual removal of building information may be performed throughout the portions of the house currently shown in the GUI, including for other types of underlying information (e.g., on images, interactive tours, 3D computer models, 2D floor map models, etc.), and that the selected type(s) of virtually removed information may in some cases be indicated with a user-selectable visual indicator to enable selection to cause additional information to be displayed (e.g., about the virtually removed information, etc.).

FIG. 2S continues the examples of FIGS. 2A-2R, and illustrates an example of the GUI updated with information corresponding to selection of control **202s** by the end user. In this example, the control **202s** is a slider that controls virtual addition of information that would otherwise not be present in the information for the building displayed in the one or more panes, such as with respect to one or more of walls or other structural elements, furnishings, furniture, fixtures, etc., and such as may be further specified using a user-selectable 'settings' control **226s** and/or based on previously selected or otherwise specified information (e.g., user preferences)—in other embodiments, one or more toggle controls may instead be used to turn on or off the virtual addition of one or more types of information. In this example, the use of the control causes building information to be virtually added that includes various kitchen information **231s** (e.g., as part of a consideration to remodel the kitchen), such as to add a kitchen island with a cooktop, to add a table and chairs, to add a new type of floor covering, etc., and further includes a structural addition **227s** (e.g., to add a master bathroom to the master bedroom by taking space from the living room). It will be appreciated that the virtual addition of building information may be performed throughout the portions of the house currently shown in the GUI, including for other types of underlying information (e.g., on images, interactive tours, 3D computer models, 2D floor map models, etc.), and that the selected type(s) of virtually added information may in some cases be indicated with a user-selectable visual indicator to enable selection to

cause additional information to be displayed (e.g., about the virtually added information, etc.).

FIG. 2T continues the examples of FIGS. 2A-2S, and illustrates an example of the GUI updated with information corresponding to selection of control 202t by the end user, such as in a manner somewhat analogous to that previously illustrated in FIGS. 2H and 2I. In particular, in this example, a type of room and/or associated functionality 221t has been selected (e.g., from a list 222t of options), which in this example corresponds to a bedroom. A corresponding partial floor plan of the house is shown with those room types and/or functionality types highlighted, including in this example to show partial floor plans for each of the floors having a corresponding room/functionality type.

FIG. 2U continues the examples of FIGS. 2A-2T, and illustrates an example of the GUI in which a visual listing of multiple types of information about a selected house is shown, corresponding to selection of control 202u by the end user. In this example, the displayed information includes an array of images captured for the house (e.g., photo 1, photo 2, etc.) and other types of building information, that in this example include a street view of the house, a 3D computer model of the house, a 2D floor map model of the house, etc.—it will be appreciated that other types of building information may similarly be shown, such as an interactive tour, videos, animations, non-visual data (e.g., audio recordings), etc. In this example, each image or other type of building information shown in the array may be selectable by the user, such as for that selected building information type to become the primary (or only) type of information shown in an updated GUI display. It will be appreciated that various other types of information may similarly be available via such an interface, such as textual information (e.g., facts about the building; a map of a surrounding area; an asking price for a building that is available for sell or other type of possible acquisition, such as rental; an estimated value for a building for a sale or other type of possible acquisition, such as based on an automated determination using a comparison to data about other similar buildings or in another manner; etc.).

Various details have been provided with respect to FIGS. 2A-2U, but it will be appreciated that the provided details are non-exclusive examples included for illustrative purposes, and other embodiments may be performed in other manners without some or all such details. For example, while not illustrated in the examples of FIGS. 2A-2U, the GUI could have other forms in other embodiments, such as to have other user-selectable and/or user-modifiable controls (whether instead of or in addition to the illustrated controls), and/or to have particular controls be accessed and used in other manners, and/or to be displayed or otherwise presented on other types of devices (e.g., desktop or laptop computers, tablet computers, etc.), and/or to be displayed or otherwise presented in other types of formats and layouts (e.g., to have more or less GUI panes, to have different layouts and/or sizes of GUI panes, to display multiple types of information simultaneously without using GUI panes like those of the examples, etc.). In addition, additional types of functionality related to displaying or otherwise presenting building interior information may be provided in other embodiments. Various other changes to the GUI may be further made in other embodiments.

FIG. 3 is a block diagram illustrating an embodiment of one or more server computing systems 300 executing an implementation of a BHP system 340, optionally one or more server computing systems 380 executing an implementation of an ICA system 389, and optionally one or more

server computing systems 370 executing an implementation of an FMGM system 379—the server computing system(s) and BHP and/or FMGM and/or ICA systems may be implemented using a plurality of hardware components that form electronic circuits suitable for and configured to, when in combined operation, perform at least some of the techniques described herein. In the illustrated embodiment, each server computing system 300 includes one or more hardware central processing units (“CPUs”) or other hardware processors 305, various input/output (“I/O”) components 310, storage 320, and memory 330, with the illustrated I/O components including a display 311, a network connection 312, a computer-readable media drive 313, and other I/O devices 315 (e.g., keyboards, mice or other pointing devices, microphones, speakers, GPS receivers, etc.). Each server computing system 380 and 370 may have similar components, although only one or more hardware processors 381 and 371, memory 387 and 377, storage 385 and 375, and I/O components 382 and 372, respectively, are illustrated for the sake of brevity.

The server computing system(s) 300 and executing BHP system 340, and server computing system(s) 380 and executing ICA system 389 if present, and server computing system(s) 370 and executing FMGM system 379 if present, may communicate with each other and with other computing systems and devices in this illustrated embodiment via one or more networks 399 (e.g., the Internet, one or more cellular telephone networks, etc.), such as to interact with user client computing devices 390 (e.g., used to view a GUI that simultaneously displays multiple types of information about an interior of a building in an integrated and coordinated manner, or to otherwise present information about a building), and/or one or more mobile image acquisition devices 360 (e.g., used to acquire images and optionally other information for buildings or other environments to be modeled), and/or optionally other navigable devices 395 that receive and use computer models and/or other building information (e.g., 2D floor maps) for navigation purposes (e.g., for use by semi-autonomous or fully autonomous vehicles or other devices). In other embodiments, some of the described functionality may be combined in less computing systems, such as to combine the ICA system 389 and the image acquisition functionality of device(s) 360 in a single system or device (e.g. via the optional ICA application 368 executing in memory 367 of the mobile device 360), to combine the BHP system 340 and/or the ICA system 389 and/or the FMGM system 379 in a single system or device, to combine the BHP system 340 and the ICA system 389 and the FMGM system 379 and the image acquisition functionality of device(s) 360 in a single system or device, etc.

In the illustrated example of FIG. 3, an embodiment of the BHP system 340 executes in memory 330 of the server computing system(s) 300 in order to perform at least some of the described techniques, such as by using the processor(s) 305 to execute software instructions of the system 340 in a manner that configures the processor(s) 305 and computing system 300 to perform automated operations that implement those described techniques. The illustrated embodiment of the BHP system may include one or more components, not shown, to each perform portions of the functionality of the BHP system, and the memory may further optionally execute one or more other programs 335—as one specific example, a copy of the ICA and/or FMGM systems may each execute as one of the other programs 335 in at least some embodiments, such as instead of or in addition to the ICA system 389 on the server

computing system(s) **380** and the FMGM system **379** on the server computing system(s) **370**. The BHP system **340** may further, during its operation, store and/or retrieve various types of data on storage **320** (e.g., in one or more databases or other data structures), such as various types of user information **322**, images and other media information **325** acquired from or about a building (e.g., received from ICA system **389**, to provide to users of client computing devices **390** for display; etc.), generated computer models and optionally floor maps and other associated mapping information **326** (e.g., received from FMGM system **379**, such as generated and saved 2.5D and/or 3D models, 2D floor maps, etc.), other types of building information **324** (e.g., annotations and other descriptions, information about points of interest, information about surrounding buildings and/or vegetation and/or other exterior information for the building, etc., such as to be determined in part or in whole from automated analysis of visual data of captured images; as well as information from end users, such as questions; information from BHP system operator users or other authorized users, such as answers to questions; etc.), and/or various types of optional additional information **328** (e.g., various analytical information related to analysis of other building information and/or end user activities).

In addition, an embodiment of the ICA system **389** executes in memory **387** of the server computing system(s) **380** in the illustrated embodiment in order to perform automated operations related to acquiring images of building interiors (and optionally exteriors of buildings, including their surroundings), such as by using the processor(s) **381** to execute software instructions of the system **389** in a manner that configures the processor(s) **381** and computing system **380** to perform such automated operations. Similarly, an embodiment of the FMGM system **379** executes in memory **377** of the server computing system(s) **370** in the illustrated embodiment in order to perform automated operations related to generating computer models and optionally floor maps of building interiors, such as by using the processor(s) **371** to execute software instructions of the system **379** in a manner that configures the processor(s) **371** and computing system **370** to perform such automated operations. The illustrated embodiments of the ICA and/or FMGM systems may each include one or more components, not shown, to each perform portions of the functionality of their respective ICA or FMGM system, and the respective computer memories may further optionally execute one or more other programs (not shown). The ICA system **389** and/or FMGM system **379** may further, during their operation, store and/or retrieve various types of data on storage **385** or **375**, respectively (e.g., in one or more databases or other data structures), such as acquired images **386**, generated computer models **376** (e.g., generated and saved 2.5D and/or 3D models) and optionally floor maps and other associated information **376** (e.g., building and room dimensions for use with associated floor plans, additional images and/or annotation information, various analytical information related to presentation or other use of one or more building interiors or other environments, etc.)—while not illustrated in FIG. 3, the ICA and/or FMGM systems may further store and use additional types of information, such as about system operator users of the respective systems, metadata about acquisition of images to be analyzed, etc.

Some or all of the user client computing devices **390** (e.g., mobile devices), mobile image acquisition devices **360**, optional other navigable devices **395** and other computing systems (not shown) may similarly include some or all of the same types of components illustrated for server computing

system **300**. As one non-limiting example, the mobile image acquisition device(s) **360** are each shown to include one or more hardware CPU(s) **361**, I/O components **362**, storage **365**, and memory **367**, with one or both of a browser and one or more client applications **368** (e.g., an application specific to the FMGM system and/or ICA system and/or BHP system) executing within memory **367**, such as to participate in communication with the BHP system **340**, ICA system **389**, FMGM system **379** and/or other computing systems—the devices **360** each further include one or more imaging systems **364** and IMU hardware sensors **369**, such as for use in acquisition of images and associated movement/travel data of the device **360**. While particular components are not illustrated for the other navigable devices **395** or other computing systems **390**, it will be appreciated that they may include similar and/or additional components.

It will also be appreciated that computing systems **300**, **370** and **380** and the other systems and devices included within FIG. 3 are merely illustrative and are not intended to limit the scope of the present invention. The systems and/or devices may instead each include multiple interacting computing systems or devices, and may be connected to other devices that are not specifically illustrated, including via Bluetooth communication or other direct communication, through one or more networks such as the Internet, via the Web, or via one or more private networks (e.g., mobile communication networks, etc.). More generally, a device or other computing system may comprise any combination of hardware that may interact and perform the described types of functionality, optionally when programmed or otherwise configured with particular software instructions and/or data structures, including without limitation desktop or other computers (e.g., tablets, slates, etc.), database servers, network storage devices and other network devices, smart phones and other cell phones, consumer electronics, wearable devices, digital music player devices, handheld gaming devices, PDAs, wireless phones, Internet appliances, and various other consumer products that include appropriate communication capabilities. In addition, the functionality provided by the illustrated systems **340** and/or **379** and/or **389** may in some embodiments each be distributed in various components, some of the described functionality of the systems **340** and/or **379** and/or **389** may not be provided, and/or other additional functionality may be provided.

It will also be appreciated that, while various items are illustrated as being stored in memory or on storage while being used, these items or portions of them may be transferred between memory and other storage devices for purposes of memory management and data integrity. Alternatively, in other embodiments some or all of the software components and/or systems may execute in memory on another device and communicate with the illustrated computing systems via inter-computer communication. Thus, in some embodiments, some or all of the described techniques may be performed by hardware means that include one or more processors and/or memory and/or storage when configured by one or more software programs (e.g., by the BHP system software **340** executing on server computing systems **300** and/or on devices **360**, by the ICA system software **389** executing on server computing systems **380**, by the FMGM system software **379** executing on server computing systems **370**, etc.) and/or data structures, such as by execution of software instructions of the one or more software programs and/or by storage of such software instructions and/or data structures, and such as to perform algorithms as described in the flow charts and other disclosure herein. Furthermore, in some embodiments, some or all of the systems and/or

components may be implemented or provided in other manners, such as by consisting of one or more means that are implemented partially or fully in firmware and/or hardware (e.g., rather than as a means implemented in whole or in part by software instructions that configure a particular CPU or other processor), including, but not limited to, one or more application-specific integrated circuits (ASICs), standard integrated circuits, controllers (e.g., by executing appropriate instructions, and including microcontrollers and/or embedded controllers), field-programmable gate arrays (FPGAs), complex programmable logic devices (CPLDs), etc. Some or all of the components, systems and data structures may also be stored (e.g., as software instructions or structured data) on a non-transitory computer-readable storage mediums, such as a hard disk or flash drive or other non-volatile storage device, volatile or non-volatile memory (e.g., RAM or flash RAM), a network storage device, or a portable media article (e.g., a DVD disk, a CD disk, an optical disk, a flash memory device, etc.) to be read by an appropriate drive or via an appropriate connection. The systems, components and data structures may also in some embodiments be transmitted via generated data signals (e.g., as part of a carrier wave or other analog or digital propagated signal) on a variety of computer-readable transmission mediums, including wireless-based and wired/cable-based mediums, and may take a variety of forms (e.g., as part of a single or multiplexed analog signal, or as multiple discrete digital packets or frames). Such computer program products may also take other forms in other embodiments. Accordingly, embodiments of the present disclosure may be practiced with other computer system configurations.

FIG. 4 illustrates an example flow diagram of an embodiment of an ICA

System routine **400**. The routine may be performed by, for example, the ICA system **160** of FIG. **1A**, the ICA system **389** of FIG. **3**, and/or the ICA system described with respect to FIGS. **1B-2U** and as otherwise described herein, such as to acquire images (e.g., 360° spherical panorama images) at viewing locations within buildings or other structures, such as for use in subsequent generation of related floor maps and/or other mapping information. While portions of the example routine **400** are discussed with respect to acquiring particular types of images at particular viewing locations, it will be appreciated that this or a similar routine may be used to acquire video or other data (e.g., audio), whether instead of or in addition to such images. In addition, while the illustrated embodiment acquires and uses information from the interior of a target building, it will be appreciated that other embodiments may perform similar techniques for other types of data, including for non-building structures and/or for information external to one or more target buildings of interest. Furthermore, some or all of the routine may be executed on a mobile device used by a user to acquire image information, and/or by a system remote from such a mobile device.

The illustrated embodiment of the routine begins at block **405**, where instructions or information are received. At block **410**, the routine determines whether the received instructions or information indicate to acquire data representing a building interior, and if not continues to block **490**. Otherwise, the routine proceeds to block **412** to receive an indication from a user of a mobile image acquisition device to begin the image acquisition process at a first viewing location. After block **412**, the routine proceeds to block **415** in order to perform viewing location image acquisition activities in order to acquire an image (e.g., a 360° panorama image) for the viewing location in the interior of the target

building of interest, optionally via one or more fisheye lenses on the mobile device to provide horizontal coverage of at least 360° around a vertical axis. As one non-exclusive example, the mobile image acquisition device may be a rotating (scanning) panorama camera equipped with a fisheye lens, such as a 180° fisheye giving a full sphere at 360° rotation. The routine may also optionally obtain annotation and/or other information (e.g., information about points of interest, other descriptions, etc.) from the user regarding the viewing location and/or the surrounding environment, such as for later use in presentation of information regarding that viewing location and/or surrounding environment.

After block **415** is completed, the routine continues to block **420** to determine if there are more viewing locations at which to acquire images, such as based on corresponding information provided by the user of the mobile device, and/or based on automated tracking of viewing locations visited (e.g., based on a predefined group of viewing locations, based on acquiring at least one viewing location in each of a predefined group of rooms, etc.). If so, and when the user is ready to continue the process (if the device is carried by the user or its movement is otherwise controlled by the user), the routine continues to block **422** to optionally initiate the capture of linking information (e.g., acceleration data and/or other data that changes as the device moves) during movement of the mobile device along a travel path away from the current viewing location and towards a next viewing location within the building interior. As described elsewhere herein, the captured linking information may include additional sensor data (e.g., from one or more IMUs, or inertial measurement units, on the mobile device or otherwise carried by the user), as well as additional video information, recorded during such movement. Initiating the capture of such linking information may be performed in response to an explicit indication from a user of the mobile device or based on one or more automated analyses of information recorded from the mobile device. In addition, the routine may further optionally monitor the motion of the mobile device in some embodiments during movement to the next viewing location, and provide one or more guidance cues to the user regarding the motion of the mobile device, quality of the sensor data and/or video information being captured, associated lighting/environmental conditions, advisability of capturing a next viewing location, information about how to reach a defined next viewing location and/or about when the defined next viewing location is reached, and any other suitable aspects of capturing the linking information. Similarly, the routine may optionally obtain annotation and/or other information (e.g., information about points of interest, other descriptions, etc.) from the user regarding the travel path, such as for later use in presentation of information regarding that travel path or a resulting inter-panorama connection link. In block **424**, the routine determines that the mobile device has arrived at the next viewing location (e.g., based on an indication from the user, based on the forward movement of the user stopping for at least a predefined amount of time, based on reaching a predefined spot for the next viewing location, etc.), for use as the new current viewing location, and returns to block **415** in order to perform the viewing location image acquisition activities for the new current viewing location.

If it is instead determined in block **420** that there are not any more viewing locations at which to acquire image information for the current building or other structure, the routine proceeds to block **425** to optionally analyze the viewing location information for the building or other structure, such as to identify possible additional coverage (and/or

other information) to acquire within the building interior. For example, the ICA system may provide one or more notifications to the user regarding the information acquired during capture of the multiple viewing locations and optionally corresponding linking information, such as if it determines that one or more segments of the recorded information are of insufficient or undesirable quality, or do not appear to provide complete coverage of the building. After block 425, the routine continues to block 435 to optionally preprocess the acquired images before their subsequent use for generating related mapping information, such as to perform an equirectangular projection for each such image so that straight vertical data (e.g., the sides of a typical rectangular door frame, a typical border between 2 adjacent walls, etc.) remains straight and in which straight horizontal data (e.g., the top of a typical rectangular door frame, border between a wall and a floor, etc.) at a horizontal midline of the image remains straight but is increasingly curved in the equirectangular projection image in a convex manner relative to the horizontal midline as the distance increases in the image from the horizontal midline. In at least some embodiments, an automated analysis of some or all of the images may further be performed to determine corresponding information about the building interior, such as types of rooms, points of interest in particular locations, etc. In block 477, the images and any associated generated or obtained information is stored for later use, and optionally provided to an FMGM routine for further analysis. FIGS. 5A-5B illustrate one example of a routine for generating a floor map representation of a building interior from the generated panorama information.

If it is instead determined in block 410 that the instructions or other information recited in block 405 are not to acquire images and other data representing a building interior, the routine continues instead to block 490 to perform any other indicated operations as appropriate, such as any housekeeping tasks, to configure parameters to be used in various operations of the system (e.g., based at least in part on information specified by a user of the system, such as a user of a mobile device who captures one or more building interiors, an operator user of the ICA system, etc.), to obtain and store other information about users of the system, to respond to requests for generated and stored information, etc.

Following blocks 477 or 490, the routine proceeds to block 495 to determine whether to continue, such as until an explicit indication to terminate is received, or instead only if an explicit indication to continue is received. If it is determined to continue, the routine returns to block 405 to await additional instructions or information, and if not proceeds to step 499 and ends.

FIGS. 5A-5B illustrate an example embodiment of a flow diagram for a Floor Map Generation Manager (FMGM) System routine 500. The routine may be performed by, for example, execution of the FMGM system 160 of FIG. 1A, the FMGM system 379 of FIG. 3, and/or an FMGM system as discussed with respect to FIGS. 1B-2U and elsewhere as described herein, such as to generate a computer model and optionally other mapping information for a defined area based at least in part on images of the area. In the example of FIGS. 5A-5B, the generated mapping information includes a 3D computer model and 2D floor map of a building, such as a house, but in other embodiments, other types of mapping information may be determined and generated for other types of buildings and used in other manners, as discussed elsewhere herein.

The illustrated embodiment of the routine begins at block 505, where information or instructions are received. The routine continues to block 510 to determine whether the instructions received in block 505 indicate to generate mapping information for an indicated building, optionally along with associated information about the building, and if so the routine continues to perform blocks 515-588 to do so, and otherwise continues to block 590.

In block 515, the routine determines whether image information is already available for the building, or if such information instead needs to be acquired. If it is determined in block 515 that the information needs to be acquired, the routine continues to block 520 to acquire such information, optionally waiting for one or more users or devices to move throughout the building and acquire panoramas or other images at multiple viewing locations in multiple rooms of the building, and to optionally further analyze the images and/or metadata information about their acquisition to interconnect the images, as discussed in greater detail elsewhere herein—FIG. 4 provides one example embodiment of an ICA system routine for performing such image acquisition. If it is instead determined in block 515 that it is not necessary to acquire the images, the routine continues instead to block 530 to obtain existing panoramas or other images from multiple viewing locations in multiple rooms of the building, optionally along with interconnection information for the images and acquisition of metadata information related to movement between the viewing locations, such as may in some situations have been supplied in block 505 along with the corresponding instructions.

After blocks 520 or 530, the routine continues to block 535 to optionally obtain additional information about the building, such as from activities performed during acquisition and optionally analysis of the images, and/or from one or more external sources (e.g., online databases, information provided by one or more end users, etc.)—such additional information may include, for example, exterior dimensions and/or shape of the building, additional images and/or annotation information acquired corresponding to particular locations within the building (optionally for locations different from viewing locations of the acquired panorama or other images), etc.

After block 535, the routine continues to block 550 to determine, for each room inside the building with one or more viewing locations and associated acquired images, a room shape of the room for data in the image(s) taken inside the room, and optionally a position within the room of its viewing location(s), such as in an automated manner. In block 555, the routine further uses visual data in the images and/or the acquisition metadata for them to determine, for each room in the building, any connecting passages in or out of the room, such as in an automated manner. It will be appreciated that, while blocks 550-555, are illustrated as separate operations in this example, in some embodiments a single analysis of the images may be performed to acquire or determine multiple types of information, such as those discussed with respect to blocks 550-555.

In block 570, the routine then determines estimated positions of the room shapes to create an initial 2D floor map, such as by connecting inter-room passages in their respective rooms, by optionally positioning room shapes around determined viewing location positions (e.g., if the viewing location positions are inter-connected), and by optionally applying one or more constraints or optimizations. Such a floor map may include, for example, relative position and shape information for the various rooms without providing any actual dimension information for the individual rooms

or building as a whole, and may further include multiple linked or associated sub-maps (e.g., to reflect different stories, levels, sections, etc.) of the building.

After block **570**, the routine optionally performs one or more steps **575-580** to determine and associate additional information with the floor map. In block **575**, the routine optionally estimates the dimensions of some or all of the rooms, such as from analysis of images and/or their acquisition metadata or from overall dimension information obtained for the exterior of the building, and associates the estimated dimensions with the floor map—it will be appreciated that if sufficiently detailed dimension information were available, a floor plan (e.g., architectural drawings, blueprints, etc.) may be generated from the floor map. After block **575**, the routine continues to block **580** to optionally associate further information with the floor map (e.g., with particular rooms or other locations within the building), such as additional images and/or annotation information. After block **580**, the routine continues to block **583**, where it analyzes, for each room in the building with one or more image viewing locations, the image(s) from the image viewing location(s) to determine information about aspects of the building interior that are visible in the image(s) (e.g., types of rooms and/or associated functionality; structural elements and other physical components of the building interior such as one or more of walls, windows, doors, stairs, fireplaces, kitchen islands, cabinets, counters, lighting fixtures, plumbing fixtures, built-in elements such as sinks and/or showers/baths and/or ovens and/or stoves and/or trash compactors and/or water heaters and/or HVAC (heating, ventilation and/or cooling) equipment and/or dish washers, moveable appliances such as refrigerators and/or clothes washers and/or dryers and/or microwaves, types of infrastructure such as using wiring and/or piping, including electrical outlets and/or cable outlets and/or telephone outlets and/or air vents and/or plumbing fixtures and/or sprinklers and/or lighting fixtures and/or speakers and/or speaker outlet/wiring locations and/or security cameras, curtains and/or other furnishings, floor coverings, materials used for surfaces such as kitchen countertops and/or wallpaper and/or paint and/or floors, furniture, fire extinguishers, etc. and optionally their locations and/or brands and/or types; other types of points of interest in particular locations; etc.), before continuing to block **585**. In block **585**, the routine further estimates heights of walls in some or all rooms, such as from analysis of images and optionally sizes of known objects in the images, as well as height information about a camera when the images were acquired, and further uses such information to generate a 3D computer model of the building, with the 3D model and the floor map being associated with each other.

After block **585**, the routine continues to block **588** to store the generated mapping information and optionally other generated information, and to optionally further use the generated mapping information, such as to provide the generated 3D computer model and/or 2D floor map for display on one or more client devices, provide that generated information to one or more other devices for use in automating navigation of those devices and/or associated vehicles or other entities, etc.

If it is instead determined in block **510** that the information or instructions received in block **505** are not to generate mapping information for an indicated building, the routine continues instead to block **590** to perform one or more other indicated operations as appropriate. Such other operations may include, for example, receiving and responding to requests for previously generated computer models and/or

floor maps and/or other generated information (e.g., requests for such information for use by a BHP system in generating and presenting a GUI that simultaneously displays multiple types of information about a building in an integrated and coordinated manner, requests for such information for display on one or more client devices, requests for such information to provide it to one or more other devices for use in automated navigation, etc.), obtaining and storing information about buildings for use in later operations (e.g., information about dimensions, numbers or types of rooms, total square footage, adjacent or nearby other buildings, adjacent or nearby vegetation, exterior images, etc.), etc.

After blocks **588** or **590**, the routine continues to block **595** to determine whether to continue, such as until an explicit indication to terminate is received. If it is determined to continue, the routine returns to block **505** to wait for and receive additional instructions or information, and otherwise continues to block **599** and ends.

FIG. **6** illustrates an example embodiment of a flow diagram for a Building Information Integrated Presentation (BIIP) system routine **600**. The routine may be performed by, for example, execution of the BHP system **140** of FIG. **1A**, the BHP system **340** of FIG. **3**, and/or a BHP system as discussed with respect to FIGS. **1B-2U** and/or as described elsewhere herein, such as to generate and present a GUI that displays multiple types of information about a building, such as simultaneously in an integrated and coordinated manner. In the example of FIG. **6**, the GUI uses multiple panes to simultaneously present multiple types of information in an integrated and coordinated manner, but in other embodiments, other types of GUIs with other types of structures and layouts may be used to present the same or similar types of information, as discussed elsewhere herein, including with respect to the examples of FIGS. **2A-2U**.

The illustrated embodiment of the routine begins in block **605**, where information or instructions are received. The routine continues to block **610** to determine whether the instructions in block **605** are to present integrated information for an indicated building, such as in a corresponding GUI. If so, the routine continues to perform blocks **615-650**, and otherwise continues to block **690**. In particular, if it is determined in block **610** that the instructions received in block **605** are to present integrated information for an indicated building, the routine continues to block **615** to obtain building information of multiple types for the indicated building, such as a 3D model of the building, images of the interior (and optionally, exterior) of the building, videos of the interior (and optionally, exterior) of the building, information about an interactive tour of a plurality of viewing/capture locations within the building interior (and optionally, exterior) at which image and/or other information was captured, a 2-D floor map or other floor plan, audio and/or textual descriptions of particular locations or areas (e.g., rooms, points of interest, etc.), simulated and/or actual lighting information, information about surrounding buildings and/or vegetation and/or other exterior aspects (vehicle traffic, foot traffic, noises, etc.), surfaces and/or areas available for virtual staging or otherwise for adding virtual objects, information about types of building information to use as POIs (e.g., information from automated analysis of visual data of images captured for the building), etc.

After block **615**, the routine continues to block **620** to determine an initial GUI display for the building (e.g., to retrieve a preexisting initial GUI to be used; to retrieve predefined information to add to the GUI; to generate the initial GUI, such as from one or more selections made in the instructions received in block **605**; etc.), such as a GUI with

three or more separate panes that simultaneously show at least three types of information about the building in a coordinated manner. In at least some embodiments, the at least three types of information may include one or more images and/or videos, at least some of the 3D computer model and/or 2D floor map model, at least some of an interactive tour, etc., such as with all of the information focused on a common location or other area of the building or other common feature or aspect. The GUI may further include various user-selectable controls (e.g., user-modifiable controls in which the user may modify a value or select from multiple options; other user-selectable controls in which functionality is toggled on and off or otherwise invoked upon selection with respect to one or more types of overlaid information, such as corresponding to POIs for one or more types of building information, including for types of building information determined from automated analysis of visual data of images; other user-selectable controls in which functionality is toggled on and off or otherwise invoked upon selection with respect to time-based controls to determine what types of corresponding building information is displayed, such as based on time of acquisition of that information; etc.) for display to an end user, such as within one or more of the separate panes or instead in separate areas of the GUI (e.g., at the top, at the bottom, on the left and/or right edges, etc.)—in at least some embodiments and situations, some or all of the user-selectable controls may be selected contextually based on other information that is displayed in the GUI, such as to have a primary pane (e.g., that is larger than other secondary page) and to overlay the content shown in the primary pane with one or more user-selectable controls that are specific to that type of content. If the GUI is to be displayed on the same computer that is executing the routine 600, the routine further generates a visual representation to supply to one or more display devices or other output devices of that computer, and otherwise generates a visual representation for transmission to another client device on which the visual representation of the GUI will be displayed. After block 620, the routine continues to block 625 to provide the generated GUI visual representation to the computer device on which it will be displayed, and then waits for an event to trigger a change in the GUI (e.g., a user selection to modify the displayed information, a change in the underlying displayed information, an amount of time having elapsed since a last user input and/or a last display activity by the routine, etc.).

After block 625, the routine continues to block 630 to determine whether the event that has occurred with respect to block 625 indicates a change in the information to be displayed for the current building, and if so continues to block 635 to determine an updated visual representation of the GUI to use as a new current GUI visual representation with the changed information, and then returns to block 625 to initiate display of the updated visual representation. The change may occur, for example, based on a user selection (e.g., of a user-selectable control in the displayed GUI) and/or a change in the underlying displayed information. In at least some embodiments and situations, the updated visual representation again shows multiple types of information in multiple GUI panes that all focus on a common area, location or other aspect of the building (whether the same common area, location or other aspect, or instead a different one) and that further include user-selectable controls corresponding to one or more panes of the GUI—in other embodiments and situations, information displayed in the GUI at a given time may include all or substantially all of the displayed area of the GUI, such as in a single pane and

optionally being of a single type. If it is instead determined in block 630 that the event that occurred with respect to block 625 did not cause a change in displayed information for the current building, the routine continues to block 650 to determine whether the event instead indicates to display information for a new building, and if so the routine returns to block 615 to initiate a display of information for the new building in an updated version of the GUI.

If it is instead determined in block 610 that the instructions or information received in block 605 are not to present integrated information for an indicated building, the routine continues instead to block 690 to perform one or more other indicated operations as appropriate. Such other operations may include, for example, receiving and responding to requests for previously generated GUI information and/or for underlying information that may be used in a GUI (e.g., information for an indicated building for display in a stand-alone manner or otherwise in a manner that is not part of an integrated display showing multiple types of related information simultaneously or otherwise concurrently; information for an indicated building that includes an array of images, such as thumbnail images, along with visual indications of additional types of media or other building information, such as a 3D model floor plan and/or a 2D floor map and/or an interactive tour; etc.), obtaining and storing information about buildings for use in later GUI presentation operations (e.g., information from external sources, such as one or more databases; information from end users, such as questions about an indicated building and/or an answer to an existing question and/or images or other media captured in or around a building; etc.), performing automated analysis of available building information and/or activities of one or more end users to determine patterns or otherwise identify additional information for subsequent use, etc.

After block 690, or if it is instead determined in block 650 that the event is not to display information for a new building, the routine continues to block 695 to determine whether to continue, such as until an explicit indication to terminate is received. If it is determined to continue, the routine returns to block 605 to wait for and receive additional instructions or information, and otherwise continues to block 699 and ends.

Non-exclusive example embodiments described herein are further described in the following clauses.

A01. A computer-implemented method for one or more computing devices to perform automated operations comprising:

obtaining, by one or more computing systems, multiple types of information about an indicated building to simultaneously show to a user in a displayed graphical user interface (GUI), wherein the multiple types of information include one or more images that are acquired at one or more respective locations associated with the indicated building at one or more respective acquisition times, and include at least a portion of a floor map of the indicated building that shows at least two-dimensional structural information for at least some of the indicated building;

presenting, by the one or more computing systems, and via the displayed GUI, the multiple types of information simultaneously in the displayed GUI, including to display the one or more images and to display the at least portion of the floor map, and to visually overlay one or more types of information on the displayed at least portion of the floor map that includes one or more visual indications of the one or more respective locations for the one or more images, and to provide a user-selectable control for use in specifying a time

associated with the one or more types of information visually overlaid on the displayed at least portion of the floor map; and

updating, by the one or more computing systems, and in response to use of the user-selectable control to specify an indicated time, the displayed GUI to modify the one or more types of information visually overlaid on the displayed at least portion of the floor map, including at least one of removing or adding at least one overlaid visual indication for at least one respective location of at least one image whose respective acquisition time is after the indicated time.

A02. A computer-implemented method for one or more computing devices to perform automated operations comprising:

obtaining multiple types of information about an indicated building to provide via a displayed graphical user interface (GUI), wherein the multiple types of information include one or more images that are acquired at one or more respective locations associated with the indicated building at one or more respective acquisition times, and include at least a portion of a floor map of the indicated building that shows structural information for at least some of the indicated building;

providing information from the multiple types for display in the displayed GUI, including to provide the at least portion of the floor map for display and to further provide a user-selectable control for use in specifying a time associated with one or more types of information available for visual overlay on the displayed at least portion of the floor map; and

providing further information from the multiple types for display in the displayed GUI based at least in part on an indicated time specified by the user-selectable control, including to provide at least one type of information to visually overlay on the displayed at least portion of the floor map, wherein the provided at least one type of information includes at least one provided visual indication of at least one of the one or more respective locations for at least one of the one or more images that has at least one respective acquisition time and that is selected in relation to the indicated time.

A03. A computer-implemented method for one or more computing devices to perform automated operations comprising:

obtaining, by one or more computing systems, multiple types of information about an indicated building to provide via a displayed graphical user interface (GUI), wherein the multiple types of information include one or more images that are acquired at one or more respective locations associated with the indicated building at one or more respective acquisition times, and include at least a portion of a floor map of the indicated building that shows structural information for at least some of the indicated building;

providing, by the one or more computing systems, a user-selectable control for the displayed GUI for use in controlling one or more types of information on a displayed at least portion of the floor map; and providing, by the one or more computing systems, further information from the multiple types for display in the displayed GUI based at least in part on indicated type of information specified by the user-selectable control, including to provide the at least portion of the floor map for display to show at least one type of information that includes the indicated type of information.

A04. The computer-implemented method of any one of clauses A01-A03 wherein the providing of the information and the further information includes performing one or more

transmissions of that information and that further information over one or more computer networks to a client computing device of the user for display in the GUI on the client computing device, and wherein the automated operations further include receiving the indicated time based on one or more interactions with the user-selectable control by at least one user of the client computing device.

A05. The computer-implemented method of any one of clauses A01-A04 wherein the provided at least portion of the floor map is part of a computer model for the at least some of the building and includes visual indications of the structural information in three dimensions that are shown in the displayed GUI, and wherein the at least one provided visual indication is overlaid on the provided at least portion of the floor map at the at least one respective location within the structural information in three dimensions shown in the displayed GUI.

A06. The computer-implemented method of any one of clauses A01-A05 wherein the automated operations further include receiving the indicated time based on one or more interactions with the user-selectable control by at least one user of the client computing device, and providing updated information for an updated display in the displayed GUI based at least in part on an indicated time specified by the user-selectable control, including to modify some of the structural information on the provided at least portion of the floor map to reflect differences in that structural information at the indicated time.

A07. The computer-implemented method of any one of clauses A01-A06 wherein the providing of the further information from the multiple types further includes providing for display the at least one image that has the at least one respective acquisition time selected in relation to the indicated time, to cause display of the at least one image in the GUI together with the displayed at least portion of the floor map.

A08. The computer-implemented method of any one of clauses A01-A07 wherein the automated operations further include receiving the indicated time based on one or more interactions with the user-selectable control by at least one user of the client computing device, and providing updated information for an updated display in the displayed GUI based at least in part on an indicated time specified by the user-selectable control, including to provide information for display about a selected image that has a respective acquisition time selected in relation to the indicated time.

A09. The computer-implemented method of any one of clauses A01-A08 wherein the automated operations further include providing a further user-selectable control for use in controlling the structural information that is shown on the displayed at least portion of the floor map, and providing updated information for an updated display in the displayed GUI based at least in part on modification of the further user-selectable control, including to modify the structural information that is shown on the displayed at least portion of the floor map.

A10. The computer-implemented method of any one of clauses A01-A09 wherein the automated operations further include providing a further user-selectable control for use in controlling virtual information that is added on the displayed at least portion of the floor map, and providing updated information for an updated display in the displayed GUI based at least in part on modification of the further user-selectable control, including to add one or more pieces of virtual information to be shown on the displayed at least portion of the floor map.

A11. The computer-implemented method of clause A10 wherein the one or more added pieces of virtual information include at least one of a piece of furniture or a furnishing or a surface covering or a plumbing fixture or a lighting fixture or an appliance or a built-in structure.

A12. The computer-implemented method of any one of clauses A01-A11 wherein the automated operations further include providing a further user-selectable control for use in controlling information that is removed from the displayed at least portion of the floor map, and providing updated information for an updated display in the displayed GUI based at least in part on modification of the further user-selectable control, including to virtually remove one or more pieces of information previously shown on the displayed at least portion of the floor map.

A13. The computer-implemented method of clause A12 wherein the virtually removed one or more pieces of information include at least one of a piece of furniture or a furnishing or a surface covering or a plumbing fixture or a lighting fixture or an appliance or a built-in structure.

A14. The computer-implemented method of any one of clauses A01-A13 wherein the automated operations further include providing additional information from the multiple types for display in the displayed GUI, including to provide one or more visual indications of one or more points-of-interest of one or more types to visually overlay on the displayed at least portion of the floor map at one or more respective additional locations of the one or more points-of-interest.

A15. The computer-implemented method of clause A14 wherein the one or more types of points-of-interest include one or more types of building information, and wherein the automated operations further include, before the providing of the additional information, automatically analyzing visual data of the one or more images to identify the one or more points-of-interest and to determine the one or more respective additional locations.

A16. The computer-implemented method of any one of clauses A14-A15 wherein the one or more points-of-interest include at least one of a wall, or a window, or a door, or a stairway, or a fireplace, or a kitchen island, or a cabinet, or a counter, or a lighting fixture, or a plumbing fixture, or a sink, or a shower, or a bathtub, or an oven, or a stove, or a trash compactor, or a water heater, or a piece of heating equipment, or a piece of cooling equipment, or a piece of ventilation equipment, or an refrigerator, or a clothes washer, or a dryer, or a microwave, or a dish washer, or an electrical outlet, or a cable outlet, or a telephone outlet, or an air vent, or wiring, or piping, or a conduit, or a plumbing fixture, or a lighting fixture, or a sprinkler, or a speaker, or a speaker wiring outlet, or a security camera, or a furnishing, or a floor covering, or a wall covering, or a material used for a surface of a countertop, or a piece of furniture, or a fire extinguisher.

A17. The computer-implemented method of any one of clauses A01-A16 wherein the automated operations further include providing a further user-selectable control for use in controlling at least one of a room type or room functionality, and providing updated information for an updated display in the displayed GUI based at least in part on modification of the further user-selectable control, including to modify a display of the floor map to visually emphasize one or more rooms on one or more levels of the building that have the at least one of the room type or the room functionality.

A18. The computer-implemented method of clause A17 wherein the modified display of the floor map shows multiple rooms on multiple levels of the building that have the

at least one of the room type or the room functionality, and further excludes at least some other rooms of the building that do not have the at least one of the room type or the room functionality.

A19. The computer-implemented method of any one of clauses A01-A18 wherein the multiple types of information further include a plurality of images that are acquired at a plurality of respective locations associated with the indicated building, wherein the providing of the information from the multiple types for display includes providing the plurality of images for display together in separate locations in the displayed GUI, and wherein the provided at least portion of the floor map is further for display together with the plurality of images in at least one additional separate location in the displayed GUI.

A20. The computer-implemented method of any one of clauses A01-A19 wherein the provided at least portion of the floor map includes at least one of some or all of a three-dimensional computer model, or some or all of a two-and-a-half-dimensional computer model, or some or all of a two-dimensional floor map model.

A21. The computer-implemented method of any one of clauses A01-A20 wherein the provided at least portion of the floor map includes at least one of some or all of a three-dimensional computer model, or some or all of a two-and-a-half-dimensional computer model, or some or all of a two-dimensional floor map model.

A22. The computer-implemented method of clause A21 wherein the indicated type of information is at least one type of structural information, and wherein the providing of the further information includes at least one or adding or removing information of the indicated type of information on the displayed at least portion of the floor map.

A23. The computer-implemented method of any one of clauses A21-A22 wherein the indicated type of information is at least one type of virtual information to be added on the displayed at least portion of the floor map, and wherein the providing of the further information includes adding one or more pieces of virtual information to be shown on the displayed at least portion of the floor map.

A24. The computer-implemented method of clause A23 wherein the one or more added pieces of virtual information include at least one of a piece of furniture or a furnishing or a surface covering or a plumbing fixture or a lighting fixture or an appliance or a built-in structure.

A25. The computer-implemented method of any one of clauses A23-A24 wherein the indicated type of information is at least one type of information to be removed from the displayed at least portion of the floor map, and wherein the providing of the further information includes virtually removing one or more pieces of information from the displayed at least portion of the floor map.

A26. The computer-implemented method of clause A25 wherein the virtually removed one or more pieces of information include at least one of a piece of furniture or a furnishing or a surface covering or a plumbing fixture or a lighting fixture or an appliance or a built-in structure.

A27. A computer-implemented method comprising multiple steps to perform automated operations that implement described techniques substantially as disclosed herein.

B01. A non-transitory computer-readable medium having stored executable software instructions and/or other stored contents that cause one or more computing devices to perform automated operations that implement the method of any of clauses A01-A27.

B02. A non-transitory computer-readable medium having stored executable software instructions and/or other stored

contents that cause one or more computing devices to perform automated operations that implement described techniques substantially as disclosed herein.

C01. One or more computing devices comprising one or more hardware processors and one or more memories with stored instructions that, when executed by at least one of the one or more hardware processors, cause the one or more computing devices to perform automated operations that implement the method of any of clauses A01-A27.

C02. One or more computing devices comprising one or more hardware processors and one or more memories with stored instructions that, when executed by at least one of the one or more hardware processors, cause the one or more computing devices to perform automated operations that implement described techniques substantially as disclosed herein.

D01. A computer program adapted to perform the method of any of clauses A01-A27 when the computer program is run on a computer.

Aspects of the present disclosure are described herein with reference to flowchart illustrations and/or block diagrams of methods, apparatus (systems), and computer program products according to embodiments of the present disclosure. It will be appreciated that each block of the flowchart illustrations and/or block diagrams, and combinations of blocks in the flowchart illustrations and/or block diagrams, can be implemented by computer readable program instructions. It will be further appreciated that in some implementations the functionality provided by the routines discussed above may be provided in alternative ways, such as being split among more routines or consolidated into fewer routines. Similarly, in some implementations illustrated routines may provide more or less functionality than is described, such as when other illustrated routines instead lack or include such functionality respectively, or when the amount of functionality that is provided is altered. In addition, while various operations may be illustrated as being performed in a particular manner (e.g., in serial or in parallel, or synchronous or asynchronous) and/or in a particular order, in other implementations the operations may be performed in other orders and in other manners. Any data structures discussed above may also be structured in different manners, such as by having a single data structure split into multiple data structures and/or by having multiple data structures consolidated into a single data structure. Similarly, in some implementations illustrated data structures may store more or less information than is described, such as when other illustrated data structures instead lack or include such information respectively, or when the amount or types of information that is stored is altered.

From the foregoing it will be appreciated that, although specific embodiments have been described herein for purposes of illustration, various modifications may be made without deviating from the spirit and scope of the invention. Accordingly, the invention is not limited except as by corresponding claims and the elements recited by those claims. In addition, while certain aspects of the invention may be presented in certain claim forms at certain times, the inventors contemplate the various aspects of the invention in any available claim form. For example, while only some aspects of the invention may be recited as being embodied in a computer-readable medium at particular times, other aspects may likewise be so embodied.

What is claimed is:

1. A computer-implemented method comprising:
obtaining, by one or more computing systems, multiple types of information about an indicated building to

simultaneously show to a user in a displayed graphical user interface (GUI), wherein the multiple types of information include multiple images that are acquired at multiple respective locations associated with the indicated building at one or more respective acquisition times, and include at least a portion of a computer model of the indicated building that shows structural information for at least some of the indicated building with surfaces of the indicated building shown using three dimensions and with information extracted from the multiple images being added to the surfaces;
presenting, by the one or more computing systems, the multiple types of information simultaneously in the displayed GUI, including to display at least one of the multiple images, and to display the at least portion of the computer model, and to visually overlay information on the displayed at least portion of the computer model that includes visual indications of the multiple respective locations for the multiple images, and to provide a user-selectable control for use in specifying a time associated with the information visually overlaid on the displayed at least portion of the computer model;
and
updating, by the one or more computing systems, and in response to specification of an indicated time via use of the user-selectable control, the displayed GUI to modify the information visually overlaid on the displayed at least portion of the computer model based on the indicated time, including at least one of removing or adding one or more overlaid visual indications for one or more respective locations of one or more images each having a respective acquisition time after the indicated time.

2. A system comprising:
one or more hardware processors of one or more computing systems; and
one or more memories with stored instructions that, when executed by at least one of the one or more hardware processors, cause the one or more computing systems to perform automated operations including at least:
obtaining multiple types of information about an indicated building to provide via a displayed graphical user interface (GUI), wherein the multiple types of information include one or more images that are acquired at one or more respective locations associated with the indicated building at one or more respective acquisition times, and include at least a portion of a computer model of the indicated building having structural information for at least some of the indicated building;
providing information from the multiple types for display in the displayed GUI, including to provide the at least portion of the computer model for display and to further provide a user-selectable control for use in specifying a time associated with information available for visual overlay on the displayed at least portion of the computer model; and
providing further information from the multiple types for display in the displayed GUI based at least in part on an indicated time specified by the user-selectable control, including to provide at least one type of information to visually overlay on the displayed at least portion of the computer model, wherein the provided at least one type of information includes at least one provided visual indication of at least one of the one or more respective locations for at least one of the one or more images that has at least one

41

respective acquisition time and that is selected in relation to the indicated time.

3. The system of claim 2 wherein the providing of the information and the further information includes performing one or more transmissions of that information and that further information over one or more computer networks to a client computing device of a user for display in the GUI on the client computing device, and wherein the stored instructions include software instructions that, when executed, perform further automated operations to receive the indicated time based on one or more interactions with the user-selectable control by the user.

4. The system of claim 2 wherein the provided at least portion of the computer model includes visual indications of the structural information that shows surfaces of the indicated building shown using three dimensions and with information extracted from the one or more images being added to the surfaces shown in the displayed GUI, and wherein the at least one provided visual indication is overlaid on the provided at least portion of the computer model at the at least one respective location within the structural information in three dimensions shown in the displayed GUI.

5. The system of claim 2 wherein the automated operations further include receiving the indicated time based on one or more interactions with the user-selectable control by at least one user, and providing updated information for an updated display in the displayed GUI based at least in part on an additional indicated time specified by the at least one user via the user-selectable control, including to modify some of the structural information on the provided at least portion of the computer model to reflect differences in that structural information between the indicated time and the additional indicated time.

6. The system of claim 2 wherein the providing of the further information from the multiple types further includes providing for display the at least one image that has the at least one respective acquisition time selected in relation to the indicated time, to cause display of the at least one image in the GUI together with the displayed at least portion of the computer model.

7. The system of claim 2 wherein the automated operations further include receiving an additional indicated time based on one or more interactions with the user-selectable control by at least one user, and providing updated information for an updated display in the displayed GUI based at least in part on the additional indicated time, including to provide information for display about a selected image that has a respective acquisition time selected in relation to the additional indicated time.

8. The system of claim 2 wherein the automated operations further include providing a further user-selectable control for use in controlling the structural information that is shown on the displayed at least portion of the computer model, and providing updated information for an updated display in the displayed GUI based at least in part on manipulation of the further user-selectable control, including to modify the structural information that is shown on the displayed at least portion of the computer model.

9. The system of claim 2 wherein the automated operations further include providing a further user-selectable control for use in controlling virtual information that is added on the displayed at least portion of the computer model, and providing updated information for an updated display in the displayed GUI based at least in part on manipulation of the further user-selectable control, includ-

42

ing to add one or more pieces of virtual information to be shown on the displayed at least portion of the computer model.

10. The system of claim 9 wherein the one or more added pieces of virtual information include at least one of a piece of furniture or a furnishing or a surface covering or a plumbing fixture or a lighting fixture or an appliance or a built-in structure.

11. The system of claim 2 wherein the automated operations further include providing a further user-selectable control for use in controlling information that is removed from the displayed at least portion of the computer model, and providing updated information for an updated display in the displayed GUI based at least in part on manipulation of the further user-selectable control, including to virtually remove one or more pieces of information previously shown on the displayed at least portion of the computer model.

12. The system of claim 11 wherein the virtually removed one or more pieces of information include at least one of a piece of furniture or a furnishing or a surface covering or a plumbing fixture or a lighting fixture or an appliance or a built-in structure.

13. The system of claim 2 wherein the automated operations further include providing additional information from the multiple types for display in the displayed GUI, including to provide one or more visual indications of one or more points of interest to visually overlay on the displayed at least portion of the computer model at one or more respective additional locations of the one or more points-of-interest.

14. The system of claim 13 wherein the one or more points of interest include one or more types of building information, and wherein the automated operations further include, before the providing of the additional information, automatically analyzing visual data of the one or more images to identify the one or more points of interest and to determine the one or more respective additional locations.

15. The system of claim 13 wherein the one or more points of interest include at least one of a wall, or a window, or a doorway, or a stairway, or a fireplace, or a kitchen island, or a cabinet, or a counter, or a lighting fixture, or a plumbing fixture, or a sink, or a shower, or a bathtub, or an oven, or a stove, or a trash compactor, or a water heater, or a piece of heating equipment, or a piece of cooling equipment, or a piece of ventilation equipment, or a refrigerator, or a clothes washer, or a clothes dryer, or a microwave, or a dish washer, or an electrical outlet, or a cable outlet, or a telephone outlet, or an air vent, or wiring, or piping, or a conduit, or a sprinkler, or a speaker, or a speaker wiring outlet, or a security camera, or a furnishing, or a floor covering, or a wall covering, or a countertop surface covering, or a piece of furniture, or a fire extinguisher.

16. The system of claim 2 wherein the automated operations further include providing a further user-selectable control for use in controlling at least one of a room type or room functionality for which information is displayed in the GUI, and providing updated information for an updated display in the displayed GUI based at least in part on manipulation of the further user-selectable control, including to modify a display of the computer model to visually emphasize one or more rooms on one or more levels of the building that have the at least one of the room type or the room functionality.

17. The system of claim 16 wherein the modified display of the computer model shows multiple rooms on multiple levels of the building that have the at least one of the room type or the room functionality, and further excludes at least

some other rooms of the building that do not have the at least one of the room type or the room functionality.

18. The system of claim **2** wherein the multiple types of information further include a plurality of images that are acquired at a plurality of respective locations associated with the indicated building, wherein the providing of the information for display includes providing the plurality of images for display together in separate locations in the displayed GUI, and wherein the provided at least portion of the computer model is further for display together with the plurality of images in at least one additional separate location in the displayed GUI.

19. The system of claim **18** wherein the provided at least portion of the computer model includes at least one of some or all of a three-dimensional computer model, or some or all of a two-and-a-half-dimensional computer model, or some or all of a two-dimensional computer model.

20. The system of claim **2** wherein the provided at least portion of the computer model includes at least one of some or all of a three-dimensional computer model, or some or all of a two-and-a-half-dimensional computer model, or some or all of a two-dimensional computer model.

21. A non-transitory computer-readable medium having stored contents that cause one or more computing systems to perform automated operations including at least:

obtaining, by the one or more computing systems, multiple types of information about an indicated building to provide via a displayed graphical user interface (GUI), wherein the multiple types of information include one or more images that are acquired at one or more respective locations associated with the indicated building at one or more respective acquisition times, and include at least a portion of a computer model of the indicated building having structural information for at least some of the indicated building;

providing, by the one or more computing systems, a user-selectable control for the displayed GUI for use in controlling one or more types of information on the at least portion of the computer model; and

providing, by the one or more computing systems, further information from the multiple types for display in the displayed GUI based at least in part on indicated type of information specified by the user-selectable control, including to provide the at least portion of the computer model for display with the indicated type of information.

22. The non-transitory computer-readable medium of claim **21** wherein the indicated type of information is at least one type of virtual information to be added on the displayed

at least portion of the computer model, and wherein the providing of the further information includes adding one or more pieces of virtual information of the at least one type to be shown on the displayed at least portion of the computer model.

23. The non-transitory computer-readable medium of claim **22** wherein the one or more added pieces of virtual information include at least one of a piece of furniture or a furnishing or a surface covering or a plumbing fixture or a lighting fixture or an appliance or a built-in structure.

24. The non-transitory computer-readable medium of claim **21** wherein the indicated type of information is at least one type of information to be removed from the displayed at least portion of the computer model, and wherein the providing of the further information includes virtually removing one or more pieces of information of the at least one type from the displayed at least portion of the computer model.

25. The non-transitory computer-readable medium of claim **24** wherein the virtually removed one or more pieces of information include at least one of a piece of furniture or a furnishing or a surface covering or a plumbing fixture or a lighting fixture or an appliance or a built-in structure.

26. The non-transitory computer-readable medium of claim **21** wherein the indicated type of information is at least one type of structural information, and wherein the providing of the further information includes at least one or adding or removing structural information of the indicated type of information on the displayed at least portion of the computer model.

27. The non-transitory computer-readable medium of claim **21** wherein the providing of the further information and the user-selectable control includes performing one or more transmissions of that further information and of information for the user-selectable control over one or more computer networks to a client computing device of a user for display in the GUI on the client computing device, and wherein the stored contents include software instructions that, when executed, cause the one or more computing systems to perform further automated operations including receiving the indicated time based on one or more interactions with the user-selectable control by the user.

28. The non-transitory computer-readable medium of claim **21** wherein the provided at least portion of the computer model includes visual indications of the structural information that shows surfaces of the indicated building shown using three dimensions and with information extracted from the one or more images being added to the surfaces shown in the displayed GUI.

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